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THE DUTY OF THE AGRICULTURAL COLLEGE[1]

A QUARTER of a century ago the sort of education for which the Kansas State Agricultural College stands was in its experimental stage. Its right to a place among the well-directed efforts of our people was seriously questioned.

That in this brief period these agricultural and mechanical colleges should completely break down opposition, allay prejudice and come into a commanding position, was beyond the hope of even their most ardent advocates.

"The influences which were set in motion by the passage of the Morrill Act have already developed a new education."[2] President Schurman, of Cornell University, recently characterized the founding of the land-grant colleges of America, through which universal industrial education was made possible, as the third and perhaps the greatest epoch in the educational history of the world.

The impress of these institutions upon the systems of education has been no less important than that upon the industries themselves. From the very beginning the instruction in the mechanic arts and engineering was successful, and the men engaged in these industries were quickly brought to a realization of this fact and accepted in full confidence the college-made engineer.

[1] Inaugural address of Professor H. J. Waters, on the occasion of his formal installation as president of the Kansas State Agricultural College, Manhattan, Kansas, November 11, 1909.

[2] President W. E. Stone, semi-centennial celebration of Michigan Agricultural College.

While in the public discussions leading to the establishment of these colleges, agriculture received chief attention, yet when they were organized few students applied for instruction in this subject, and for many years little impress was made upon the farm practises of the country. It is, in truth, only within the last decade that a system of instruction and research has been developed and perfected that is shaping the policies and destinies of this, the oldest and most important occupation of man.

It was one of the most fortunate circumstances connected with the creation of these colleges that the act of Congress bringing them into existence was comprehensive enough with respect to their purpose and objects to admit of the teaching of a wide range of subjects. The comprehensive charter with which they were vested permitted of extensive experimentation in courses of study, a wide adaptation in subjects taught, arrangement of courses, methods of instruction, etc. Untrammeled by tradition, they were free to make experiments in the subject matter taught, as well as in the method of teaching it.

Broadly speaking, there has been assigned to this class of colleges, in the natural division of labor, the great industrial problems of our people, including the development and conservation of the material resources of the country, as well as the great economic and sociological questions affecting the industrial classes.

As interesting as the history of the development of these colleges is, and as rich in history as this particular member of the group is, on an occasion like this a glance into the future is perhaps more appropriate, for it is there that our problems lie.

COMPETITION IN EDUCATION

The American ambassador to Great Britain recently facetiously referred to our educational system as America's chief industry. In other ways it is frequently suggested that in this matter the rate of growth has been out of proportion to our development in other directions and beyond our real needs.

Of the eighteen million children in the graded schools in the United States to-day, less than a million, or less than one in twenty, will ever matriculate in a high school or an academy. Moreover, of the nine hundred thousand pupils in the secondary schools, only about two hundred thousand will be enrolled in our colleges and universities, or approximately one out of every four.

It requires, therefore, approximately eighty pupils in the grades to supply one college or university student. Less than one in five of these college and university matriculates graduates. Therefore, over four hundred graded school pupils are required to furnish one college graduate.

Of more significance than all this is the fact that seven out of every eight of the boys and girls of the United States leave school between the fifth and sixth grades and go out into a world of splendid opportunities without the training and intellectual power to enable them to take advantage of these opportunities.

It would not seem, in the light of these facts, that there was much serious competition in education. In fact, it does not appear that we are doing very much to break down human ignorance and overcome human prejudice.

TAKE THE COLLEGE TO THE PEOPLE

While it is of paramount importance that the college give thoroughly sound instruction to the young men and young women in residence, it is equally true that its activity must not end here. More and more must the college be carried to the people. At best but a small proportion of

those who should avail themselves of its advantages can leave home.

Farmers' Institutes.—This phase of the college work, as it affects the farmer, is already well organized and bringing splendid results. Through the farmers' institutes, farmers' conventions, instruction trains, demonstration farms, etc., the whole state is being reached. It is expected that the representatives of the college will this year come into personal touch with fully seventy-five thousand farmers and farmers' wives, or more than one out of every three farmers in Kansas. It is possible that it will soon be found necessary to offer courses in agriculture and home economics of varying lengths in different parts of the state, to accommodate the increasing demand for instruction in these subjects on the part of those who can not leave home.

Outlying Experiments.—It is not sufficient to conduct experiments at Manhattan and Fort Hays and call the problems finally settled in accordance with the teachings of these results. Kansas is a large state, with a great variety of soils, and great variation in rainfall and in plant and animal adaptation. As soon as funds for this purpose can be provided and the work so organized that it may proceed in each case along lines that are fairly certain to yield profitable results, there should be instituted systematic tests or experiments in every county in the state. This will be found profitable not only because of the exact information secured, but by reason of the greater confidence which the farmers will have in the results, because they were secured under conditions which they recognize as identical with their own.

Then, these experimental fields may also serve an exceedingly valuable educational purpose, by being so planned that they demonstrate some point in agricultural practise of especial importance to the community in which they are established.

Farm practise is developing at so rapid a rate and so many methods are being found to succeed well under one set of conditions and not under another, that for the individual farmer to try, at his own expense, all that good judgment indicated might be worth trying, would mean that his farm must become an experiment station instead of a business enterprise. It is, therefore, the business of the state and federal government to put these things to the test for him, and under conditions closely approximating his own.

State Surveys.—For the first time in our history, we have become interested in the conservation of our resources. A young nation, like a young person, is proverbially profligate of its resources. Ours has been a waste of the resources of soil and forest and stream that is without parallel in the history of the world. This waste has been largely due to improper systems of farming, and can not continue another century without bringing ruin to America's basic industry. Under the teachings of institutions like this, larger returns may be secured without depleting the soil than are now secured under a system of land spoliation. This is a matter of concern not only to the landowner, but to the whole of society, since the future welfare of our cities and factories and churches and schools is directly dependent upon the returns from the farm.

We are now in a frame of mind to consider methods of checking this waste. The first step is to take account of stock. The Kansas landowner needs to know what types of soil he has, what amount of plant food each contains, to what each is best adapted, and how it may be managed to yield the largest return without having its productiveness diminished. The college

should at once organize a state soil survey, and push it towards completion as rapidly as the facilities provided by the state and federal government will permit. This is fundamental to all agricultural progress. Later, surveys of special industries or crops should be instituted, to determine upon what types of soil and under what conditions they are succeeding and under what conditions they fail, that it may form the basis of researches to point out the way to make them successful under all conditions.

A corn and forage plant survey, to extend the boundary of successful farming still further westward, is an enterprise in which this state can well afford to engage.

Conserving Water Power.—These efforts should not be limited to agriculture. A series of investigations and experiments looking toward the conservation and utilization of the water supply of the state, for the purposes of both irrigation and power, is a duty which the college owes to the public. There are doubtless many localities in which sufficient power could in this way be developed to supply the needs of farm and village within the radius of twenty or more miles. In many other places hydraulic power could be developed sufficient to furnish light and power for from one to a dozen farms.

The loss to crops from improperly distributed rainfall in this state is enormous. In many places water could be economically stored during the wet seasons, to be used for irrigation purposes when the rains fail. In other localities, the underground supply of water might be profitably utilized by a proper method of pumping.

The protection of life and property against floods is a matter of serious importance, and commends itself to our favorable consideration. Water purification and sewage disposal are as yet unsolved problems for the greater proportion of the state.

Tests should be carried on to determine the draft and efficiency of farm implements with the expectation of establishing standard designs for the different conditions of soil.

Kansas produces gas, oil and coal in large quantities. Much of this has been wasted in the past and is being wasted under present conditions. A series of tests conducted on a commercial scale will do much towards establishing standard methods for the preparation and use of these materials.

The gasoline engine will, for some time to come, be the principal prime mover for small units in this state. The cost of gasoline is constantly increasing. Under present conditions denatured alcohol can not be used economically. Investigations that will lead to methods of manufacture of denatured alcohol at a low price, and to methods of producing gas from Kansas coal successfully, will do much to extend the use of this type of engine and to cheapen the cost of power.

THE COUNTRY ROAD

Of more importance than all of these is the country highway. We have, through long use, worn out the natural roads, and have not yet found a successful substitute. Through the recently created department of public highways of the college, however, it is expected that we shall be able to educate the people concerning the importance of this matter. Moreover, through this means the college is now pointing out the most satisfactory way of maintaining earth roads, imparting information in regard to the best systems of permanent culverts and bridges, and as rapidly as the people of a community will assume the cost, will supervise the construction of permanent roads.

At all times the people have been found

ready to pay taxes for permanent public improvements, if they are confident that the money will be judiciously expended. It is through careful supervision by the experts of the college that the ordinary mistakes of the planning and construction of these highways and bridges will be avoided.

PRODUCTION AND DISSEMINATION OF IMPROVED PLANTS AND ANIMALS

The colleges of agriculture must lead in plant and animal improvement. A plan of improvement instituted by an individual is seldom carried beyond his lifetime. In a college, if well managed, a program of improvement may be carried forward without interruption for many generations, indeed indefinitely. It will be highly profitable for the state to encourage the more general use of better farm crops and live stock, by disseminating these improved strains, through the college. Already a large impress has been made upon the agriculture of Kansas, in both plants and animals, and experiments are now in progress which it is confidently expected will yield even more important economic results.

THE EXPERIMENT STATION

The primary function of the experiment station is to extend the domain of human knowledge. It has been the chief factor in creating agricultural knowledge. It was the experiment station which won back to the college the confidence of the farmer, which confidence had been forfeited for lack of ability to lead him.

It is the experiment station which has supplied the teacher with accurate and well-organized knowledge to impart in the class room. It has been the experiment station which has provided the way for these institutions to become real leaders in the realm of agriculture and has exerted an influence upon agricultural practise that is epoch-making.

It is an admirable work to turn out young men trained for leadership on the farm and capable of going among farmers as teachers of correct systems of agriculture, or to lead young men who come to the college to a better knowledge of the subject; but, after all, the greatest work these colleges have to do is to equip men with the proper knowledge and the necessary inspiration to advance the world's knowledge and to supply these thousands of teachers with something to teach.

It is, therefore, a fundamental mistake to assume that the duty of the experiment station is solely or even principally to benefit the farmer directly. A larger responsibility rests upon it—that of making an exact science of agriculture, so that it may be successfully taught in the colleges, the high school, the graded school, the farmers' institutes, and on demonstration farms.

The value of research is not limited to the industries. It is the very life of a teaching institution such as this. It gives point to the instruction. The teacher who is an investigator is a live teacher; no man can long keep alive as a teacher and not conduct researches.

RESEARCH TO ENCOURAGE MANUFACTURES

But research in these institutions has been restricted to too narrow a field. Little attention has been given to problems other than production problems. The effort has all been in the direction of making two blades of grass grow where one grew before; or of increasing man's efficiency with this or that machine. The time has come when its influence should be materially extended. The wastes of a rural community are not all to be found in the processes incident to production. An equal waste occurs in the marketing and utilization of the materials produced.

The investigations should, therefore, include agricultural manufactures and the

utilization of the wastes on the farm. Factories should be developed in the country, near the sources of production, for the preparation for final consumption of the materials grown on the farm. Such factories are necessary for the highest degree of economy in the production of food and to give the laboring man an opportunity to gain a livelihood outside of the congested city. Foodstuffs are already too high to stand the strain of the additional cost of transporting the raw materials long distances in order that they may be manufactured into edible form, then shipped back to the consumer in the very community in which they were grown, and where their manufacture might have been accomplished to better advantage.

In countries where the raw materials of our foodstuffs are chiefly grown, there they should be chiefly manufactured. Kansas wheat should be milled in Kansas. Just as the experiment station has made a profound impress upon the methods of farming, so may it improve the methods of manufacturing the products of the farm. The millers of the state need just such scientific assistance as the station can provide, all with a view not so much to helping the miller directly as to improving the quantity and quality of the foodstuffs garnered from the Kansas wheat fields.

THE ECONOMICS OF MARKETING

Such vital questions as how to dispose of the products that they may yield the largest returns, or how to spend the income so as to bring the best results in the highest sense, have been practically neglected.

To correct this one-sided development and meet this larger demand, the department of history of the college should be so strengthened and enlarged as to cover, both by instruction and by research, the industries of our country. The department of economics should be prepared to fully cover the range of transportation, manufactures, marketing, etc., as they relate to the farming and industrial classes. The department of sociology should deal with the life of the people in the open country and in the districts supported by the industries, and be able to suggest plans for their immediate and permanent improvement.

The department of architecture should make a large impress upon the homes and public buildings of the state, and upon the location and arrangement of the accessory buildings that they may conserve the strength of the housewife, afford the sanitary conditions essential to health and add to the comfort and pleasure of country life.

AMERICANS LIVE WASTEFULLY

Americans, poor and rich, live wastefully. This can not continue. A new basis must be established which shall, while avoiding the extreme care and economy of continental Europe, which destroys initiative and kills pride, stop the major wastes in our system of living.

But of more importance than mere economy of living is the influence of the environment and method of living upon the race. Will out of it all in the long run come a strong and virile race of people—a race capable of meeting the complex problems of the future and advancing still further our civilization?

It is especially appropriate to emphasize this point in the institution which, among the land-grant colleges at least, has been a leader in this line, and which to-day boasts the largest and perhaps best equipped department of domestic science and art in America.

As much, however, as has been done in this direction here and elsewhere, and proud as we have a right to be of the record of this college in this direction, real

work has been hardly begun and we scarcely realize what this great movement means and what will be its future development. Certain are we, however, that it means something more than the mere teaching of young women how to sew and how to cook. It has involved in it the whole question of home building and the rearing of a strong and virile race of people. The dream of the ancients, a strong mind in a sound body, is thus beginning to be realized. But we have only just come to take this view of the matter and have scarcely begun work on this broad basis. Times are strangely out of joint when we justify the extensive scientific inquiries into the way to rear a strong and vigorous race of pigs or sheep or colts or cattle, and are content with the very meager knowledge which we possess of the nutrition of men. We have millions for research in the realm of domestic animals, and nothing for the application of science to the rearing of children. Exhaustive studies are made upon the life histories of animals of the lower orders, while vital facts in regard to the life history of our children remain a sealed book. We know how the *amœbæ* develop, but are content to remain in ignorance of what factors contribute to the development of a strong body and a sound mind in mankind. For centuries we have let the injunction "Know thyself" go unheeded, and have forgotten that "The greatest study of mankind is man."

For every dollar that goes into the fitting of a show herd of cattle or hogs or into experiments in feeding domestic animals, there should be a like sum available for fundamental research in feeding men for the greatest efficiency. The Kansas State Agricultural College ought to take advanced ground here, and build up the greatest institute of research in human nutrition in the world. The federal government should be interested and cooperate with the state and community in matters of this sort.

THE EXODUS FROM THE FARM

It is common to lament the tendency of the best men and women to leave the farm and go to the city as a modern or present-day tendency, whereas it is as old as civilization itself.

Plutarch in his "Præcepta Politica" protested against the threatening invasion of large cities; Cicero thundered against the depopulation of the rural districts through similar attractions to those which draw young men and young women from the farm to-day. Even Justinian, the great law maker, was in favor of legislation designed to keep the people on the farm.

The great Roman Emperor Augustus before the Christian era saw that his empire was being undermined and the strength of his people sapped by the exodus from the country to the city, and called to him the poets of the nation and commanded them to sing of the beauties and profits of country life, in order to attract his people back to the land. This trend cityward has been to a great degree due to the half education which has prevailed in the rural districts and which has given the farm boy glimpses of the more attractive city life without teaching him at the same time how he may attain such a life at home.

For the first time in history this situation is sought to be met by making a profession of farming, so that it may be attractive to the intellectually strong, at the same time that the returns are large enough to command the reasonable comforts and luxuries of life. These countervailing influences, however, will be found to be inadequate unless they strike at the very root of the difficulty—the farm home, the country road, the rural school and the country church.

VOCATIONAL SUBJECTS IN THE PUBLIC SCHOOLS

This means that vocational subjects must be introduced into the courses of study in the grades and in the high schools, as well as in the colleges and in the universities. So rapidly and so fully has instruction in vocational branches been developed, that the best and cheapest places to learn farming or stock raising or dairying is now, not on the farm, but in a college. The horse doctor has been displaced by the college-trained veterinarian. The place to learn to sew and to cook and to build and manage a home is, not in the home, but in a college. The period of apprenticeship of the machinist has been supplanted by a course at college, and the employers of engineers no longer look elsewhere than to the colleges for this training. But gratifying as all this is to us, we must realize that at best the problem of bringing industrial education within the reach of the masses, and this is the great problem, is very far from being solved. In the nature of the case, but a small proportion of the people can attend college. It has already been pointed out that less than a dozen of every thousand pupils in the graded schools go to college. When we consider that these twelve are divided among the various courses offered by our colleges and universities, such as academic theology, law, medicine, teaching, journalism, agriculture, engineering, etc., we realize how small a proportion of the boys and girls of the country really come under the influence of this sort of instruction when it is confined to the college. To reach the masses with this work, it will be necessary to introduce it into the high schools and grades the country over. In the city schools, home economics and manual training, with agriculture optional, and in the country schools, home economics and agriculture, with manual training optional.

To the objection that these subjects, especially home economics and agriculture, of a character suited to the grades and high schools, are not yet teachable, I urge that they are far more teachable than were these same subjects of college grade twenty years ago, and that if we will apply ourselves to the problem of reducing them to pedagogical form with the same zeal and determination that characterized the efforts of the college teacher, equally satisfactory results will be forthcoming.

To the objection that the teachers are not prepared, I answer that the demand for teachers so prepared is all that is necessary to fully meet this difficulty.

INDUSTRIAL SUBJECTS IN HIGH SCHOOLS FIRST

Success will come first in the high school, and next in the grades, for the same reason that it came first in the college. The high school to-day must be something more than a mere connecting link between the graded school and the college or university. It is more than the successor to the academy with the burden of support laid upon the public. It is in the strictest sense the people's college, and affords the highest education that the majority who go beyond the grades will ever get. It should do something more than merely fit for college the great masses who will never attend college; it should fit for the duties of life.

Already the city high schools have reached a fair degree of development in this direction, and the trend towards the industrial and vocational has been as rapid as could be expected or as is perhaps desirable. Their courses of study are already reasonably well adapted to the needs of the people who live in the city. It is a serious mistake, however, to pattern too closely after these city high schools in planning to meet the needs of those who live in the country. Careful consideration

should be given to the pupil's environment and experience as well as to his probable future occupation.

AGRICULTURE IN THE RURAL SCHOOLS

This is the next great educational problem. In fact the rural school to-day, considered broadly, presents the most serious educational problem with which we have to deal. How to shape the instruction in this unorganized, isolated and poorly equipped school so that the pupils may not lose sight of the farm, its life, its problems, its beauties, and its profits, is the great question now before us. The hope of these schools and of our system of public education lies, not in the abandonment of these country schools, not in the attempt to substitute something else for them, but rather in making them serve their constituency in the best way and contribute most to the development of the boy or girl who is fortunate enough to have been born in the country.

The problem does not consist in the long run wholly or even mainly in finding a suitable teacher, although this is perhaps for the moment the limiting factor in progress.

As Professor Bailey has well said:

> If a room or a wing were added to every rural school house, to which children could take their collections and in which they could do work with their hands, it would start a revolutuion in the ideals of country school teaching, even with our present school teachers.

In short, our rural school system needs to be so revised that from the very outset the courses, to quote the words of a distinguished English educator, "shall be woven around knowledge of the common phenomena of the world. . . . For it should be the purpose of these elementary schools to assist boys and girls according to their different needs to fit themselves practically as well as intellectually to the work of life."

I do not wish to be understood, in quoting the foregoing approvingly, to advocate the making of the graded or high schools narrow or provincial. Nor would I permit these schools to become in any sense professional—except possibly the last two years of the course in a first-class high school. This might appropriately be made as severely professional as the funds for providing the additional teachers and equipment would permit.

INDUSTRIAL SUBJECTS WILL VITALIZE

The benefits to accrue from the successful introduction of agriculture, home economics and manual training into the schools will not be confined to the direct influence which this instruction may have upon the industries involved, but this will be found to be the best way to vitalize elementary schools, and especially those in rural communities. Just as these useful subjects gave new life to our college courses, so will they be found capable of vitalizing the elementary courses.

TRAINING THE TEACHER

As before intimated, the lack of suitably trained teachers for this work is temporarily the limiting factor in our progress. Where the teacher shall receive his training, and of more fundamental importance, of what it shall consist, are questions not yet answered. Thus far no very satisfactory place for securing this training has been provided. A number of agricultural colleges of the country are offering courses in agriculture, etc., especially for teachers, and these in the main have been successful.

Congress recently recognized this lack in our educational system, and provided, in the Nelson amendment to the Morrill Act,

that a portion of the increased support thereby given the colleges of agriculture might be used for "providing courses for the special preparation of instructors for teaching the elements of agriculture and mechanic arts."

Whether experience will in the end show that the normal school, with agriculture, home economics and mechanic arts added, or the agricultural colleges, with sound courses in education added, will best meet this situation, or whether it may not indeed become expedient to employ both methods, I will not at this time hazard a guess. We are all, I take it, more interested in having this work done and done well, than in the question of where or by whom it shall be done. Certainly there are many people now teaching who desire to equip themselves to teach agriculture. These naturally would be best served by courses at the agricultural college.

EXPERIMENTS IN TEACHING INDUSTRIAL SUBJECTS

To my mind, there can be no question as to the propriety and profitableness of establishing at the agricultural college, where agriculture, home economics and mechanic arts reach their highest development, and where there is the greatest interest and enthusiasm in these subjects, systematic investigation of the methods of teaching these subjects of a grade suitable to the requirements of high schools and rural schools. A sort of pedagogical experiment station for the systematic study of these and kindred problems is no less important than are agricultural experiment stations, to study questions relating to corn and wheat growing and the raising of live stock, and no less logical than engineering experiments to study questions in relation to bridges, highways, sanitation, etc.

KANSAS'S OPPORTUNITY

Much as we may deplore the lack of suitably prepared teachers to introduce these vocational subjects into the schools of the rural districts, and much as we may feel the lack of adequate knowledge and experience along this line, the really fundamental difficulty in the way of a satisfactory system of rural schools, primary and secondary, is the lack of sufficient funds. Wealth in rural communities is not sufficiently concentrated to afford the revenue necessary for this purpose. In many portions of the country the returns from the farm are so meager as to scarcely permit the schools to be maintained on their present low plane. The farmers of Kansas, however, are prosperous—perhaps more prosperous, on the average, than the farmers of any other section of the world. They therefore owe it to themselves, to their less fortunate neighbors, and to their profession, to give of their means in sufficient amount to develop the most efficient system of rural education the world has known.

FARMER OR PEASANT

It is not primarily a matter of increased financial return, but has involved in it the future welfare of America's agriculture. Further advancement must be based upon the increased intelligence of the man who is to till the soil, together with his better understanding of the fundamental laws of nature with which he has to deal.

If the American farmer is to prove an exception to the history of the world and remain the independent, thinking, reading, progressive individual that he has thus far been instead of becoming a peasant, as he has before in all history, it is necessary that he be given the broadest possible training, and be educated most thoroughly in the fundamental principles underlying his profession.

THE INDUSTRIAL AND THE CULTURAL MUST GO TOGETHER

It is said that an ancient and honorable university once wrote over its portals: "No useful knowledge taught here." I would not go to the opposite extreme and write over the portals of even this institution—the child of a strictly utilitarian age—the legend: "No subject that is not useful taught here." I would make all the courses practical enough to fit men for efficient service in their several professions and pursuits of life, and at the same time liberal enough to prepare them for the highest service as citizens.

The best part of an educational institution is its spirit—is the point of view which it gives its students—the ideals which they carry away from its halls and through life, for of more worth than fine gold is a quickened conscience and a capacity to distinguish between what is right and what is wrong.

A high ideal is the noblest gift man can bestow upon man. Feed a man, and he will hunger again; clothe him, and he will become naked. Give him a noble ideal and that ideal will abide with him through every waking hour, giving him a broader conception of his relation to his fellows. The ideal must be so far above us that it will keep us looking upward all our lives and so far in advance that we shall never overtake it.

Those whom we send out must make a large contribution to the welfare of the world.

GREAT TEACHERS MAKE A GREAT SCHOOL

We point with a pardonable pride to our splendid group of buildings, the broad expanse of fertile soil which constitutes the college farm, the improved plants and animals, boasting of both a distinguished lineage and an honorable career, to the shops and equipment of laboratories and libraries, to the new athletic fields and gymnasium in immediate prospect, and to our other material possessions, and unconsciously make the sum of these, the college.

It is, however, the teacher who determines the worth of the school. We have no means of measuring the value of a great teacher. It was in the musty law office of John Wythe that Thomas Jefferson studied, as did also one of the greatest judges that ever sat upon the supreme bench, John Marshall, and also the greatest orator that ever electrified an audience in his period of the world's history, Patrick Henry. John Wythe was himself chancellor of Virginia, and a great man, but great chiefly for the men he made.

Given a good teacher, and locate him in a cellar, an attic or a barn, and the strong students of the institution will beat a path to his door. Given a weak teacher, and surround him with the finest array of equipment that money can buy, and permit the students to choose, as in the elective courses, and his class room will echo its own emptiness.

A poor teacher in a German university, where all subjects are elective, is a matter of comparative indifference, but in an institution such as ours, where the courses of study are fixed, to keep a poor teacher year after year and require hundreds of young men and women to waste their time in his classes, is little short of a crime.

Economy in teachers' salaries is false economy, and will quickly react upon the institution and upon the state. Low salaries mean cheap teachers and low-grade work. The twenty-five hundred or more students who come here annually to secure an education have a right to demand the best. To lose our best teachers the moment we have developed them to a high degree of efficiency, because we can not meet the salary paid in kindred institutions is deplorable in the extreme. Or to secure good teachers and so load them with work

that they can not render the most efficient service is an equally poor policy.

It should be the business of those entrusted with the administration of a college to secure the best men available, supply them with such facilities as will make them content, and then have the wisdom to let them alone.

WORLD LEADERSHIP REQUIRED

Large and important as is the service this institution has rendered to the industries of the state, and great as are the problems of this sort for the future to solve, the service of greatest moment, the principal return which the Kansas State Agricultural College and similar institutions make for the large outlay of public funds —the real justification for their existence —is their capacity for developing in men and women the qualities of leadership. The public mind does not grasp and successfully grapple with great fundamental principles, but is apt to concentrate itself upon some detail—of one sort to-day, of another to-morrow. It is essential that we have leaders of public thought who see broadly and clearly, for, as Mirabeau says, "It is equally as important for those to be great thinkers who are to execute the laws as for those who made them." Homer realized the scarcity of such men, and, as given us by Pope, said:

Too few and wondrous few has Jove assigned
A wise, extensive and all-consid'ring mind;
They are guardians, these, the nations round confess,
And town and countries think their safety blest.

Situated as we are, in the very center of the largest expanse of fertile land the world has, with a climate neither so warm as to weaken nor so cold as to dwarf, but the climate which has produced the most virile and progressive races of people—the races which have in all recent history dominated the world, no one can foretell what the future holds. Certain it is that here will be the greatest concentration of population and wealth. Here all things for which we are striving must reach their highest development. No longer will it be necessary for us to look to the east or to Europe for inspiration and guidance in education, in engineering, in agriculture, in how to live rationally. In very truth, the men of the east and of Europe will come here to learn. This means that the men of to-morrow, the young men who are now in school, must assume larger responsibilities than have devolved upon us—the responsibilities of world-leadership in the entire range of human affairs. It is imperative therefore that our systems of government, education, agriculture, manufactures, etc., shall be such as to withstand the severest test of science and human experience in order that they may furnish a rational example and guide for those less blest.

COLLEGES MAKE LEADERS

In the absence of a great epoch or crisis in human affairs, such as the opening up of a new continent, the invasion of a country by a foreign foe, or an internal strife such as our recent civil war, the college and university must be depended upon to develop the world's leaders in all lines of activity. The state and nation, to make certain that every youth with latent qualities of leadership may have within his reach, be he poor or rich, the uplifting and stimulating influence of the highest education the world affords, did establish and endow this and kindred institutions. It is upon this basis only that our civilization can be secure. No class of people, however large, cultured, or refined, is large enough, or intellectual enough, or refined enough, to supply all the leaders the state and nation require. It is only when all are drawn from all classes that we shall have enough, and be certain that we have

the best. It is as Carlyle has said of the tragedy of ignorance:

> It is not because of his toils that I lament for the poor; we must all toil, or steal (howsoever we name our stealing), which is worse; no faithful workman finds his task a pastime. The poor is hungry and athirst; but for him also there is food and drink; he is heavy laden and weary; but for him also the Heavens send Sleep, and of the deepest; in his smoky cribs a clear dewy heaven of Rest envelopes him, and fitful glitterings of cloud-skirted Dreams. But what I do mourn over is that the lamp of his soul should go out; that no ray of heavenly, or even of earthly knowledge should visit him; but only in haggard darkness, like two spectres, Fear and Indignation bear him company. Alas, while the Body stands so broad and brawny, must the Soul lie blinded, dwarfed, stupefied, almost annihilated? Alas, was this, too, a Breath of God, bestowed in Heaven, but on earth never to be unfolded?—That there should one Man die ignorant who had capacity for knowledge; this I call a tragedy were it to happen more than twenty times in the minute, as by some computations it does. The miserable fraction of Science which our united Mankind, in a wide Universe of Nescience, has acquired, why is not this, with all diligence, imparted to all?

Mr. President: Assured as I am of the loyal support and cooperation of the board of regents, faculty, students, alumni and citizens of this great state of Kansas, at the same time realizing the full weight of its responsibilities, and conscious of my own limitations and weakness, and pleading for both charity and patience, I accept the high office of president of the Kansas State Agricultural College. May He who marks the sparrow's fall take us all into His keeping and guide our thoughts aright.

PHYSICS TEACHING IN THE SECONDARY SCHOOLS OF AMERICA[1]

WE understand the present fully only in the light of the past. Hence, if we would grasp the meaning of the present situation so clearly as to be able to see the way out, we must first study the history of science teaching in America.

Mathematics has had a long and an honorable academic career. But the natural sciences are relatively new as subjects of formal instruction in schools. Although physics appears to have been taught to freshmen at Harvard for two fifteen-minute periods a week as early as 1670, the sciences do not appear on the list of subjects required or accepted for entrance to college until the year 1870, when Harvard added the elements of physical geography to its list. Physics appeared in 1876. The demand for popular and useful studies had led the academies to introduce the sciences of geography, natural philosophy and astronomy early in the nineteenth century. The colleges did not recognize these, however, till about fifty years later.

When we remember that the academies were founded in response to a popular demand for an education that should train boys and girls so that they might be useful members of the community, we see: (1) That the sciences were brought into the schools for their practical utility; (2) that the colleges followed the schools in their recognition of the value of science after an interval of about eighty years, and (3) that science was introduced into the schools in response to a demand on the part of the people who supported the schools and in spite of the colleges.

In order to make clear the subsequent development, I shall consider largely the subject of physics, partly because physics has been more prominent in the schools; partly because I am better able to follow its changes with sympathy; and also because I believe that the history of physics is typical of that of the other sciences. Let us then glance at the methods of teaching physics in 1876 when that science

[1] Address delivered at the conference of the University of Illinois with the secondary schools of Illinois, November 19, 1909.

made its début among the subjects required for admission to college.

We can get a very good idea of what was taught under the name of physics by examining some of the books used for texts like Comstock's or Wells's "Natural Philosophy," or Rolfe and Gillett's "Handbook of Natural Philosophy." This latter work was the one specified for use in preparing for the entrance examination at Harvard, so we will use it for purposes of comparison.

The Rolfe and Gillett contains two hundred and thirty pages, exclusive of the appendix which was not required. The modern texts, Millikan and Gale, Adams, Mann and Twiss, contain, respectively, 482, 478 and 456 pages; on the average, an increase of over 100 per cent. In like manner the number of numbered paragraphs in the required portion of the Rolfe and Gillett is 351; that in the modern texts just mentioned is 614, 560 and 416, respectively, an average increase of about 50 per cent. It thus appears that the amount of subject matter that has been crowded into the course has been very materially increased. It is a noteworthy fact, however, that this increase consists in the addition of new topics rather than in the change of old ones for new, *i. e.*, the old course given in 1876 contained only the necessary elements of any course, because modern developments have failed to displace them.

The first great change that has taken place since physics became a college entrance subject has been this great increase in number of topics considered necessary for the course. The present course is acknowledged on all sides to be badly overcrowded. Can any teacher make twenty or more pupils master or even learn thoroughly and clearly understand 614 numbered paragraphs, each containing, by reason of being numbered, a new idea or principle, in 180 forty-minute periods? This means just eleven minutes and 43.6 seconds to a paragraph—and this interval must include all the discussion, problems, experimental demonstrations, quizzes and laboratory work. Is it a wonder that teachers who attempt this do not succeed? And this without reference to the content of the paragraphs. Under such conditions it is far less remarkable that 70 per cent. of the applicants fail on the written examination of the College Entrance Board than it is that 30 per cent. pass.

Are the college entrance requirements responsible for this overcrowding of the time allotted to the course? This is a leading question and it may be answered by either yes or no, according to the interpretation put on it. If you treat it as a legal question, as a question of whether "it is so stated in the deed" or not, the answer will be an unequivocal no. The early Harvard requirements and the definition framed by the National Educational Association and that issued by the College Examination Board have never contained any syllabus of topics required. Hence this superabundance of topics is not written in the deed and the college requirements are not to blame. There is one exception to this statement and that is New York University, which has issued a syllabus of required topics. This syllabus is a model of logical arrangement, but is at least twice as long as any syllabus for a one-year course in physics should be.

Well, then, if the college requirements are "not guilty" in the documentary sense, what has been the source of the congestion? It is, of course, impossible to lay all the blame on any one thing, because the conditions under which this overcrowding has developed have been so complex. All will agree, however, that the first cause is

to be found in the fact that the science itself has made such rapid progress since 1876. This development of the science has been paralleled by a remarkable growth of the spirit of scientific research and a large increase in the number of specialists in physics who are devoting their entire time to investigation in this field alone. Add to this the attitude of the universities toward research in that they demanded research work of their physicists as a prerequisite to academic promotion, and you have all the elements necessary to crowd more and more subject matter into the preparatory course. The teachers in the schools caught the spirit of the universities, and all hands turned to a well-intentioned but, as it has proved, a futile effort to introduce into the elementary course as much of the precision, the rigor and the abstraction of the research laboratory as was possible. The highly specialized science of physics became king and the abilities and needs of the pupils were lost sight of.

This development was fostered by textbook writers, publishers and apparatus dealers. Every new text had to go its competitors one better in the matter of being "up-to-date," in order that the publishers' agents might have new "talking points" with which to allure the unwary superintendent or school-board member. No publisher would print a book that did not contain accounts of all the recent discoveries and a few more, because the publishers had found out that teachers would turn down a book because it did not contain X-rays or wireless telegraphy, ions, electrons or radium. Up-to-date-ness was considered the first virtue.

Another example of this increase in the amount of subject matter may serve to leave this first point clear in mind. The 1888 edition of Gage's "Introduction to Physical Science" contains 340 pages and 321 numbered paragraphs. Under the pressure of up-to-date-ness, Gage wrote an enlarged book called the "Principles of Physics," and the latest revised edition of this book, 1907, contains 529 pages and 562 numbered paragraphs. Thus we see that, although the abilities and tastes of the pupils have remained fairly constant, and although little effort has been made to prepare them for the work by teaching more elementary physical science in the grammar schools, the amount of subject matter that we are trying to teach them in the same time has increased from 50 to 60 per cent. This increase alone is enough to make it impossible for the teacher now to do thorough work, without regard to the nature of the topics added or to the content of the subject matter. This one thing is enough seriously to have impaired the efficiency of the science work.

Nevertheless, this increase in the amount of the subject matter is by no means the only factor that has been at work in rendering the science teaching less effective than it might be. When we compare the subject matter taught thirty years ago with that in the modern texts as to content, we find again a marked contrast.

Thus by comparing the topics under "a" in the index of the Rolfe and Gillett with those in the index of the latest of the new texts, that of Adams, I find but two topics in the former not treated in the latter; and thirty in the new book not found in the old. The old topics omitted are *annealing* and *artesian wells*. The most important new topics introduced are *aberration, chromatic and spherical; absolute temperature, absolute units, acceleration, air thermometer, alternating currents, ammeters, astigmatism, Atwood machine*. These few give an idea of the sort of things that have been added. A

similar proportion holds for the rest of the indices.

It will be noted that the topics omitted in the new book are of the "practical" type—annealing and artesian wells, while most of those added in the new book treat of unfamiliar subjects not likely to be met with outside the physics laboratory—spherical aberration, absolute temperature, absolute units, air thermometer, Atwood machine—topics of a highly specialized type demanding the use of abstract, difficult, and to the pupils, unusual ideas for their mastery. When we recall that the teacher has just 11 minutes and 43.6 seconds in which to make each topic clear to a class of twenty or more, we need not be surprised that the students find the subject unintelligible, and that they carry away only a rather confused jumble of words in the place of clear, definite and usable ideas.

Because these technical topics are unfamiliar, the student does not see their use or value—and many of them are useless to the majority of the pupils—so they have no significance to him, and hence he has no motive that impels him to study them with enthusiasm.

An example may help to make this point clearer. In the early editions of Gage the problems are of this type: "What amount of work is required to raise fifty tons of coal from a mine two hundred feet deep?" "Twelve hundred foot-pounds of energy will raise a one-hundred-pound boy how high, if none of it is wasted?" In the most recent books we find problems like this: "How much work is done in lifting a 10 kg. mass vertically 180 cm.? Give the answer in kilogrammeters, in ergs and in joules." "What force in dynes will lift a mass of five kg.? How many ergs of work are done in lifting a mass of 5 kg. 20 cm.?" "A pull of one dyne acts for 3 seconds on a mass of one gm. What velocity does it impart?" Or again, in the Rolfe and Gillett, Newton's second law of motion is stated thus: "A force has the same effect in producing motion, whether it acts on a body at rest or in motion, and whether it acts alone or with other forces."

The modern text states this: "Rate of change of momentum is proportional to the force acting, and takes place in the direction in which the force acts." If we did not understand Newton's law, but were trying to learn it for the first time, which of these statements would be the more intelligible? Which would leave us with the clearer and more usable idea? The latter statement has been introduced for the sake of greater rigor; but taking it simply as an English sentence, have we gained in rigor by making the student memorize the statement that a *rate of change* takes place in a certain *direction?* This statement of the law is what Carl Pearson in his "Grammar of Science" calls a metaphysical summersault. And have we not thereby converted the old and valuable "science of things familiar" into a "nescience of things familiar"?

Hence the second important fact in the development of the teaching of science is that we have not only added to the number of topics to be learned, but have also changed the content of the old topics so as to render them almost, if not entirely, unintelligible to beginners. Any one who has taught classes of teachers in a summer school, or has visited elementary classes in physics, must have noticed that many of the "laws and principles" of physics, as they are expounded in the modern texts, are none too intelligible to many of the teachers themselves. How then can we expect to have the pupils leave their work with clear, definite, usable ideas? This change

in the content of the ideas presented, or of the point of view from which the phenomena are now presented, would alone account for the decrease in the success and efficiency of physics teaching in the past decade. Elementary physics has lost much of its pragmatic value and become somewhat rationalistic because of its devotion to various and sundry "absolutes."

But besides the increase in the amount of subject matter and the "absolute" unintelligibility of some of it to beginners, there is a third great and important fact in the history of physics teaching in America. This fact is that the method of presenting the subject has changed in several important ways. We can get a good idea of the condition of physics teaching in the secondary schools in the seventies from two bulletins that were issued by the National Bureau of Education in 1880 and 1884, respectively. The first was edited by Professor F. W. Clarke, of the University of Cincinnati, and it contains reports concerning the teaching of physics and chemistry from 176 public and 431 private secondary schools. From a study of this report it appears that in 1880 there were but four of the 607 schools giving a full year of work in physics with laboratory experiments by the pupils. Fifty-three were giving full year courses with experiments by the teacher. One hundred and thirteen were giving courses in physics with no experiments at all—merely text-book recitations. The rest had courses for part of a year only, but almost all had some physics.

It is not necessary to make any comment on the difference between this situation and the present one, where practically every school has its laboratory work by the pupils. This change from practically no individual laboratory work to laboratory work for everybody means, as every science teacher must see at a glance, a tremendous advance. It is also clear that the college entrance requirements have been of the greatest assistance in hastening this progress. Beginning in 1886 with the Harvard requirements, and followed up in 1897 by the definition of the unit requiring laboratory work by the committee on College Entrance Requirements of the National Educational Association, the colleges have contributed all that in them lay toward the acquisition of this very valuable asset for science teaching. A detailed account of how the college requirement was framed and how it has been altered has been given by Professor E. H. Hall, of Harvard, in his book on the "Teaching of Physics," and more recently in his contribution to SCIENCE for October 29, so that we need not pause for this now. Suffice it here to point out that physics teaching owes a great debt of gratitude to the colleges generally, but to Professor Hall and Harvard in particular, for this acquisition of laboratories for physical science in the schools. By the introduction of the laboratory work the teaching of science has been enormously benefited; and, had the teachers held the subject matter of the course down to the comprehension of the pupils, there would doubtless be no cause for complaint now.

The second of these bulletins from the bureau of education was edited by Professor C. K. Wead, of the University of Michigan, and deals largely with methods of instruction. It contains replies to a circular letter issued by the bureau, a discussion of these replies, a number of reports on physics work abroad, some valuable suggestions on teaching of physics, and a list of forty-seven topics and forty-two experiments, which were regarded as fundamental for every elementary physics course. It is interesting to note that this list, issued in 1884 by the U. S. Bureau of

Education, contains three quarters of the topics on the list of the North Central Association which was issued in 1908. It is not seriously different from the truly celebrated Harvard description list of 1886, or the list of experiments in the new College Entrance Board's requirements. The report also shows that twenty-five of the thirty secondary schools reporting expressed themselves as regarding laboratory work as necessary. This shows a great advance between 1880, when the Clarke bulletin was issued, and 1884. Thus laboratory work was being introduced rapidly before the college pressure was applied in 1886, and the reports show that it was of a kind to possess significance to the pupils —done with home-made apparatus and "kitchen utensils."

This report contains much valuable advice which has not been followed in the subsequent course of events. Thus, p. 116: "Above all, it should be taught in each kind of school for the benefit of those who will go no further." Again, p. 117:

> The weight of opinion is decidedly that the first teaching should be inductive. . . . The progress of the student following this method is so slow, if measured by the usual examination tests, as to discourage a faint heart. . . . When pushed to the extreme just indicated (to learn everything for himself) the method breaks down; for quantitative experiments are mostly beyond the reach of high school boys, and yet very few principles or laws can be established without them. . . . If to reason accurately on physical facts be of any value to the student, is not a conclusive disproof of an hypothesis (provided he originated it) more valuable than the incomplete proof with which he must usually remain contented when he learns the accepted hypothesis? . . . Consciously or not, we must use inductive methods all our lives in ways where we can not avail ourselves of the principle of the division of labor, depending on others. The professional opinions of the physician and lawyer, all our judgments of men and our opinions on common matters of life must be largely the result of inductive reasoning. Another reason for introducing inductive training into the schools is that, in the opinion of many teachers, more of physics can be taught so as to be remembered in this way than in any other. . . . The use of text-books of the ordinary kind, however accurate and clear, is inconsistent with, perhaps almost fatal to, the scientific method in schools.

Again, p. 103:

> The difference between certainty and probability or conjecture, between truth and opinion, is one which the educator would not fail to make felt. . . . To keep the scholar in an atmosphere of real or apparent certainty, when in after life three fourths of his intellectual occupation will be to deal with uncertainties, is as foolish as it would be to keep him out of the water until he has learned to swim.

Thus in the matter of facilities for presenting the subject of physics, substantial progress has been made in the acquisition of the laboratory; but in the matter of knowing how to treat the subject, we have made little progress—many think we have gone backward.

Somehow most of the students regard the subject matter as so much "stuff" that has to be gone over, and speak of the laboratory exercises as so many "stunts" that have to be performed in order to get credit. The work as a whole lacks significance to them, so that they do not, as a rule, work at it with initiative and enthusiasm. The present condition was sized up so aptly by President Remsen in his address before the American Federation of Teachers of the Mathematical and the Natural Sciences in Baltimore last year, that I can not refrain from quoting him:

> A battle that has long been waging has been won—the battle for the recognition of science in the courses of study in schools and colleges. . . . Now science is recognized; we have laboratories everywhere and laboratory training is regarded as indispensable. It is therefore fitting to ask: What are we doing with our facilities? What results are we obtaining? When the battle was on, men lost their heads—men must lose their heads in order to fight. We thought that if only we could

get laboratories, the problems of education would be solved. Is this true? Are we doing the best that is possible with what we now have? Do the results obtained justify the equipment and time devoted to scientific study? I am not qualified to answer these questions for the schools; but speaking for the colleges, I may say that in my opinion the results are frequently quite unsatisfactory. The reason is that we have not yet learned how to deal with the subject. It is not hard to teach chemists chemistry, but it is very hard to teach beginners something that is worth while about chemistry in one year.

The leading facts of the past history of science teaching and the present problems are now before you.

We have not yet learned how to deal with our subject. It is not hard to teach physicists physics, but it is very hard to teach beginners something that is worth while about physics in one year.

It is essentially an educational problem, and, again quoting President Remsen's address:

Pedagogical problems are hard to solve—it is very difficult to get sound conclusions. How can we tell whether the scientific training is more effective than that of the older type? This is a problem that can not be solved by sitting down and thinking about it; it can be solved only by research and experiment. I do not myself know whether scientific training as now conducted is producing the results hoped for. Yet I am convinced that scientific training, when properly conducted, may be of the greatest value as an educational force. This is quite a different thing from saying that that particular thing now known as science training is of great value. It all depends on how it is done. I have been experimenting to find out how to teach chemistry, and it is the most difficult experiment I have ever tried.

"The problem can not be solved by sitting down and thinking about it;" nor, may I add, can it be solved by getting up a perfect list of experiments, or, by writing a text that shall be the most logical, accurate and rigorous in the world. "The problem can be solved only by research and experiment and it is the most difficult experiment I have ever tried." Progress in the future depends, then, on our applying to our teaching problems the methods of our subjects; for surely no one needs to tell a body of science teachers what the words research and experiment mean. How, now, shall we go about it?

The first step is to define specifically the problem we are going to try to solve. The problem as stated above, namely, to give the pupils something worth while, is too vague to permit of scientific experiment, because it offers no method of testing the work for the purpose of finding out whether we have succeeded. What do we mean by "something worth while," and how shall we test the pupil to find out whether he has acquired it? Those of our parents who studied physics in the sixties and seventies testify now that they acquired from their school work in physics an investigating attitude toward problems, and clear enough ideas of some of the more important principles to have helped them considerably ever since. But such evidence as this comes rather late, and, while it is interesting and throws some light on the subject, it is not the sort of evidence that science demands. The problem must be more specific and the results of the experiments must be more definite. We must therefore seek a more definite statement of the problem, and this necessitates first a decision as to what the purpose of the teaching is to be.

The number of purposes for teaching physics that have been suggested and defended in the past thirty years has been large. Two, however, have been rather more fundamental than the others, so we will confine our attention to these. The first in the public mind at present is the one given in the report of the Committee on College Entrance Requirements of the National Educational Association, to which the College Entrance Board gave until this year a protecting shelter. It is thus

written in the deed: "To the end that the pupil may gain a comprehensive and connected view of the most important facts and laws of elementary physics." This purpose leads to the very specific question: Do the pupils get such a view under the current system of instruction? This question can be answered—nay, is answered, with perfect definiteness on all the examination papers written by the pupils. Need I tell a body of physics teachers what the answer is? How many papers each year convince you that the writers have either a comprehensive or a connected view of the most important facts and laws? For myself, I do not hesitate to answer; very few; and, as a college teacher who must build on the comprehensive and connected view implanted by others, I must confess that I am seldom able to discover it. In some few students it is there, but in the great majority it is not.

Under these conditions it seems perfectly fair to question whether the present habits of teaching are sound and to try to find out what is the matter. Two sources of trouble have already been pointed out. In our efforts to make the view comprehensive, we have overcrowded the course to the point where we have but eleven minutes forty-three and six tenths seconds to a topic. In our efforts to make it connected, logically connected, we have become rationalists and resorted to the "absolute," thereby making much of it unintelligible. One scientific experiment would consist in reducing the subject matter, forsaking the absolutes, and then testing all along for the clearness of view gained. Another would consist in presenting the same topic to several different classes by different methods to see if some previously unintelligible topics might be made intelligible if differently treated. Numerous other experiments will at once suggest themselves, all aimed at finding the best way of "giving a comprehensive and connected view" of such facts and principles as were introduced. In this matter there is no royal road to success. Each teacher must find out for himself how best to succeed with his particular class.

The second important purpose of teaching science does not seem to have received much attention of late. It has not been a protected commodity like the other. Its statement is best given in a report of a committee on teaching of elementary physics that was presented to the British Association for the Advancement of Science in 1874.

> They have assumed as a point not requiring further discussion that the object to be attained by introducing the teaching of physics into general school work is the mental training and discipline which the pupils acquire through studying the methods whereby the conclusions of physical science have been established. They are, however, of opinion that the first and one of the most serious obstacles in the way of the successful teaching of this subject is the absence from the pupils' minds of a firm and clear grasp of the concrete facts and phenomena forming the basis of the reasoning processes they are called upon to study. They therefore think it of the utmost importance that the first teaching of all branches of physics should be, as far as possible, of an experimental kind. Whenever circumstances admit of it the experiments should be made by the pupils themselves and not merely by the teacher, and though it may not be needful for every pupil to go through every experiment, the committee think it essential that every pupil should at least make some experiments himself.
>
> For the same reasons, they consider that the study of text-books should be entirely subordinate to attendance at experimental demonstrations or lectures, in order that the pupils' first impressions may be got directly from the things themselves and not from what is said about them. They do not suppose that it is possible in elementary teaching entirely to do without the use of text-books, but they think they ought to be used for reviewing the matter of previous experimental lessons rather than in preparing for such lessons that are to follow.

It will be noted that the purpose herein set forth is the one favored by most of the contributors to Professor Wead's bulletin just reviewed. It seems to have been the prevailing idea prior to and at that time, 1884. As stated above, our parents tell us now that they actually did get from their study of physics an inquiring attitude of mind, and the ability to attack and solve problems. One of the correspondents in Professor Wead's bulletin states that the introduction of physics in his school has had the effect of quadrupling the number of boys that go to high school! That the purpose we have been discussing is fast becoming the teaching purpose of science at the present time, no one who has followed closely the trend of recent educational thought can seriously doubt. And if this is so, a large and interesting array of definite problems that can be answered only by experiment presents itself. The main question now is not—Has he gained a comprehensive view? but—Has he acquired a certain power? It is no longer—What does he know? but—What can he do? No longer—How much can he reproduce? but—How well can he produce?

We already have some data concerning the way the present system of teaching is serving this second purpose. Such data are obtained by setting original problems on examination or in the laboratory. And here again such data as I have collected have led me to the belief that none of us are succeeding over well at this. Nor need we expect to succeed so long as we follow mainly the didactic methods that have been found useful in other kinds of work. Power in solving problems is acquired only by solving problems under the spur of an inner motive of wonder, not by listlessly listening to a description of how some one else has solved them.

We have here a wide and important field for educational research. We know comparatively little about the most efficient means of developing power of solving problems. Mighty few of our texts treat the subject with a questioning attitude or in a way to develop this in the pupil. Open any text at random and read the heading of a new paragraph. Thus:

> In 1686 Sir Isaac Newton formulated three statements which embody the results of universal observation and experiment on the relations which exist between force and motion. The statement of the first law is, etc. A machine is a contrivance for the transference of energy, or both the transference and transformation of energy at the same time; it is therefore an instrument for doing work. It is an accepted belief among men of science that all space is filled with something so rare and subtle that it can not be weighed or indeed perceived by any of our senses, and to this all-pervading medium the name of *ether* has been given. (This last is the first sentence in the subject of light.)

Surely such treatment does not tend to develop power of solving problems in the pupils. But fortunately the teachers do not always follow the text: some let the text follow them. When this is the case, much may be done toward developing power of solving problems and initiative among the pupils. Yet such cases are the exception rather than the rule. Each of us can, however, find out how to do it if only he will recognize the fact that his daily task is a daily problem, requiring study and experiment for its solution, and then attack that problem resolutely and continue experimenting and carefully testing results until they are satisfactory.

In order to summarize the distinction I have been trying to make in the last few pages, let me again quote from Professor Wead's bulletin:

> If the thing to be aimed at is to make them pass a good examination as soon as the subject is read, the best means will be to put a text-book into the hands of every one, and require certain parts of it to be learned, and to illustrate them

in an experimental lecture with explanations. The lecture may be made very clear and good; and this will be an attractive and not difficult method of teaching, and will meet most of the requirements. It fails, however, in one. The boy is helped over all the difficulties; he is never brought face to face with nature and her problems; what cost the world centuries of thought is told him in a minute; his attention, clearness of understanding, and memory are all exercised; but the one power which the study of physical science ought preeminently to exercise, and almost to create, the power of bringing the mind into contact with facts, of seizing their relations, of eliminating the irrelevant by experiment and comparison, of groping after ideas and testing them in their adequacy, in a word of exercising all the active faculties which are required for an investigation in any matter—these may lie dormant in the class while the most learned lecturer experiments with facility and explains with clearness.

In what has been said I have dealt only with the most evident of the problems now before the physics teachers—namely, the problem of how to teach so as to leave the pupil with an added power to achieve. I have given it as my frank opinion that we are not oversuccessful in this at present, have urged that scientific experiment in teaching offers the only means of finding out how to become more successful, and have suggested several working hypotheses as possible guides to such experimenting. The subject has, however, only been grazed by what has been said. No mention has been made of the contributions that physics teaching might make to the social efficiency of the community; nor has the problem of making the physics contribute its share to moral education been considered. The questions as to why America does not contribute her just quota to the number of the world's greatest scientists have not been discussed. These larger problems of science will have to be left for future discussion. Their solution, like that of the problem that has occupied our attention, is waiting for the scientific experiments in education, which alone can lead us to a satisfactory conclusion.

C. R. Mann
The University of Chicago

The Eighth Zoological Congress

The preliminary announcement of the eighth International Zoological Congress is just issued and of it we make the following abstract. The congress meets at Graz, Austria, on August 15–20, 1910, under the presidency of Hofrat, Professor Ludwig von Graff, who was elected to the position at the Boston Congress in 1907.

At 9 A.M., on Monday, is the registration, followed by a meeting of the permanent committee of the congress and an inspection of the university. At 3 P.M. are the general formalities of opening, with addresses of welcome, presentation of delegates, formation of sections and the like. At the close of the session the members go to the Heimwald, where there will be an informal gathering in the restaurant.

On Tuesday and the following days the general sessions are at 9, with sectional meetings at 2 in the afternoons, and on Tuesday and Wednesday there are lantern lectures on Styria and the Dalmatian coast. From 4:30 on there are small excursions to the beautiful places in the surrounding mountains. On Friday evening the congress proper ends with a banquet to the congress.

On Saturday the congress goes on an excursion to the Erzberg and Leopoldstein See and on Sunday to Trieste, where the Austrian Zoological Station forms the chief object of interest. If possible the beautiful Imperial Castle of Miramar (associated in the minds of Americans with the unfortunate Maximilian of Mexico) will be visited.

From Monday, August 22, to Saturday evening, there will be an excursion in one of the steamers of the Austrian Lloyds down the Dalmatian coast, stopping at Rovigno, Pola, Sebenico, Traú, Spoleto, Lesina, Lissa, Meleda, Ragusa and Cattaro. Ample time will be allowed at the latter place for a trip

to the mountain town of Cettinje, the capital of Montenegro. On this trip the party will have meals and will sleep on the steamer. The cost is estimated at about 200 kronen, about $40, but this may be reduced, provided sufficient numbers take the excursion. Definite responses concerning it must be in the hands of the committee by June 1, next.

There is also offered a supplementary excursion which is most attractive to those who enjoy the out of the way. It leaves the other on the return trip at Ragusa, and goes into the mountains by rail to Mostar, the capital of Bosnia, and then to Sarajevo, the capital of Herzegovina, and thence to the end of the railway at Jaice. Then comes a carriage ride of about thirty or forty miles to the railroad at Banjaluka, where the train is taken again for Agram, the end of the excursion. On this trip there will be many stops, but the names of the stations mean little to most Americans. This supplementary excursion will occupy a week and the cost will be about $40 additional. It will be under the charge of the Bosnian-Herzegovinan Landes-Museum, thus guaranteeing the best of introduction to the strange lands of the Balkans.

Anyone interested in zoology is eligible to membership in the congress, the cost being 25 kronen (about $5.00). The wives and daughters of members may join as participants. Members have all the rights usually associated with membership (the fee being 12 kr.), and are to receive the publications of the congress. None but members and participants are entitled to attend the meetings of the congress or to take part in the excursions.

A second circular, giving full particulars of the sections, a list of hotels and boarding houses and other information will be issued in March, and this with the present circular will be mailed to all who request it. All communications should be addressed to the Praesidium des VIII. Internationalen Zoologenkongress, Universitätsplatz, 2, Graz, Austria. Postal orders or drafts for membership fees should be drawn in favor of the "VIII. International Zoological Congress" and be sent to the Steiermärkische Escomptebank at Graz.

Titles of all papers to be presented to the congress must be received before August 1, 1910, in order to have a place on the program; and as soon as the paper is read the manuscript must be handed to the secretary in complete shape, ready for printing.

THE DEPARTMENT OF AGRICULTURAL EDUCATION OF THE UNIVERSITY OF WISCONSIN

PROFESSOR KARL HATCH, who has charge of the newly organized department of agricultural education in the University of Wisconsin College of Agriculture, is formulating plans for assisting rural and high schools in their efforts to give effective instruction in agriculture. A traveling library of lantern slides illustrating various phases of dairying and farming has been provided which will be sent to schools for use. A collection of enlarged photographs of agricultural products and materials has also been prepared. An explanation of the methods of using the bulletins issued by the Experiment Station and the U. S. Department of Agriculture has also been provided, which is designed to make available for instruction the material in these official publications. The college of agriculture has arranged to have a number of its faculty deliver special lectures on teaching agriculture at county teachers' institutes.

A special annual appropriation of $30,000 for agricultural extension work, made by the last state legislature, has resulted in the expansion of this work until it now includes eleven different branches. The extension work in the department of horticulture includes demonstrations of the spraying of potato fields and of orchards, the distribution of pure-bred tobacco seed, the inspection of orchards and nurseries for destructive insects and fungous growths and assistance in landscape gardening.

Means of control and eradication of weeds are given through the agronomy department, which also disseminates pure-bred grains and seeds of forage plants among the farmers, in-

spects the seed sold by dealers to detect the seeds of noxious weeds and other foreign matter, conducts corn contests for young people, and cooperates with the farms of state and county institutions in demonstrating to the farmers of the neighborhood the best methods of handling their crops, from seeding to harvesting. For a state so recently redeemed from forest to agricultural use, the stump removal investigations of the extension department are of importance, as are also the lines of work in cranberry culture for the marsh districts, the extension farmers' courses, held for several days at a time in communities remote from the college, often in connection with homemakers' conferences under the auspices of the home economics department.

The department of agricultural economics has begun an investigation of the cost of farm products through a system of blanks to be filled out daily by farmers in typical portions of the state and tabulated at the close of the year by the department in cooperation with the U. S. Department of Agriculture. An employment bureau for graduates and former students of the college is also maintained by the department of agricultural economics through which farmers, dairymen and stock raisers can secure the services of young men especially trained for the branch of work for which they are desired.

Plans for the construction of farm buildings are prepared by the department of agricultural engineering, while the soils department promotes the reclamation of waste swamps through the organization of drainage districts, tests soils to find what form of fertilizer they need and advises as to crop-rotation to renew exhausted wheat lands. An improvement in the breeds of horses raised in Wisconsin has resulted from the stallion licensing system of the department of horse breeding, as improvement in other kinds of farm stock has come from the work of the animal husbandry department in forming dairy cattle breeders' associations, sheep and swine breeding societies and live stock judging contests.

Cooperating with the State Live Stock Sanitary Board and the State Veterinarian, the department of agricultural bacteriology investigates outbreaks of animal diseases with a view to control and elimination, as well as the causes of bad water supplies for villages and cities. The post-mortem tuberculosis demonstrations of the department at county and state fairs and other meetings have been a means of education to thousands of people as to the serious nature of the disease and the necessity and means of prevention.

Improvement in dairying through the distribution of starters for the making of butter and cheese, the testing of milk and cream, and monthly exhibitions at the dairy school where butter and cheese is scored as to its merits and defects has been an accomplished aim of the dairying department of the extension service, while the chemistry department has also assisted in this work through its tests of dairy cows as to production, to help farmers to weed out the poor producers. The inspection of feeds and fertilizers according to recent license laws has protected the farmers from the harmful ingredients often found in such commercial products before the department undertook the work. These means employed by the Agricultural College are aimed toward reaching the 200,000 farmers of the state with the results of the scientific investigations of the college and experiment station laboratories.

THE GEORGE WASHINGTON MEMORIAL BUILDING

We are requested to print the following letter calling the attention of members of the American Association for the Advancement of Science to the plan for the construction and endowment of a building in Washington to be used as headquarters for our national scientific organizations:

Washington, D. C.,
June 1, 1909.

Dr. L. O. Howard,
Permanent Secretary, A. A. A. S.

Dear Sir: I take great pleasure in bringing to your attention the project of the "George Washi-gton Memorial Association" for the erection of

a building in the City of Washington to be known as the George Washington Memorial Building in commemoration of our first president and his interest in science and higher education in America.

At the present time there are no suitable facilities for bringing together at Washington the national patriotic, scientific, educational, literary and art activities. The association proposes to secure funds necessary for the erection of a building, well located, attractive in appearance, practical in plan and construction, and of the most durable character. It is to be planned so as to furnish a home and gathering place for national patriotic, scientific, educational, literary and art organizations that may need such accommodations, including the Washington Academy of Sciences and its sixteen affiliated societies. It will furnish a place where all the patriotic societies, both north and south, may testify to their love for the father of this country. The building will contain a great hall, or auditorium, and rooms for large congresses, such as the recent Tuberculosis Congress; rooms for small and large meetings; office rooms and students' research rooms.

In addition to the Memorial Building it is intended to secure an endowment adequate for its maintenance.

The advantages of a permanent home for the American Association for the Advancement of Science are too obvious to require further comment. The project has received the endorsement of the National Academy of Sciences, the Washington Academy of Sciences and its affiliated societies, the Association of Physicians and Surgeons, the National Association for the Study and Prevention of Tuberculosis and other national scientific and art organizations.

The George Washington Memorial Association is conducting an active campaign and is meeting with gratifying success in its efforts to obtain subscriptions.

To the scientific organizations of this country, and to our association, which is in need of a permanent home, such a building has an especial value, and members are urgently requested to cooperate in securing contributions.

While large subscriptions are desirable, I invite your favorable consideration to the following extracts from the appeal for the building fund.

This building must be the nation's tribute to Washington. Every one of us must have a part in it. I ask you to contribute one dollar each to this building, and in this way we will accomplish a most patriotic purpose and also have provided for carrying out in the highest sense the great thought of Washington, which as yet has not been recognized by the American people in any concrete form. A receipt with engraved head of Washington will be sent to each contributor and the name and address of each contributor will be entered in the permanent record of this great undertaking. The entrance fee shall be five dollars, which will cover the dues for the first year, to be remitted to the treasurer. The annual dues shall be two dollars, payable on or before the thirtieth day of January.

SUSAN WHITNEY DIMOCK,
President George Washington Memorial Association

It affords me great pleasure to second this appeal, and to request that you mail your contributions to Dr. L. O. Howard, Smithsonian Institution, Washington, D. C., so that in due time they may be transmitted as the offering of the members of the American Association for the Advancement of Science to a great and worthy cause.

Very respectfully yours,
DAVID STARR JORDAN,
President A. A. A. S.

SCIENTIFIC NOTES AND NEWS

As has already been noted the Royal Society has this year awarded its Copley medal to Dr. G. W. Hill, For.Mem.R.S., for his researches in mathematical astronomy; other awards are royal medals to Professor A. E. Love, F.R.S., for his researches in the theory of elasticity and cognate subjects and to Major Ronald Ross, F.R.S., for his researches in connection with malaria; the Davy medal to Sir James Dewar, F.R.S., for his researches at low temperatures, and the Hughes medal to Dr. R. T. Glazebrook, F.R.S., for his researches on electrical standards.

THE honors awarded on the occasion of King Edward's birthday include the following: Privy councillor, Sir Henry Roscoe, F.R.S.; knights, Professor W. A. Tilden, F.R.S., professor of chemistry and dean of the Royal College of Science, London, and Mr. E. H. Shackleton, the leader of the recent antarctic expedition. Professor A. H. Church, F.R.S., professor of chemistry in the Royal Academy of Arts, has been appointed a knight commander of the Royal Victorian Order (K.C.V.O.). Mr. T. L. Heath, Sc.D.,

principal clerk of the treasury, has been promoted to be knight commander of the Bath (K.C.B.), and Dr. Sven Hedin has been appointed an honorary knight commander of the Indian Empire (K.C.I.E.).

Professor L. A. Wait, head of the department of mathematics at Cornell University, where he has been professor since 1870, will retire from active service at the close of the present year.

Dr. Ernst Wilhelm Ebermayer, professor of agricultural chemistry at Munich, has celebrated his eightieth birthday.

Professor William Bateson has been elected president of the Cambridge Philosophical Society.

Sir William Noven, K.C.B., F.R.S., has been elected president of the London Mathematical Society.

Dr. M. P. Ravenel, professor of bacteriology at the University of Wisconsin, has been appointed "Official Rapporteur" to the International American Congress at Buenos Ayres next May, where he will have charge of the program devoted to tuberculosis.

Sir T. H. Holland, F.R.S., professor of geology and mineralogy in Manchester University, will deliver the Wilde lecture of the Manchester Literary and Philosophical Society for 1910.

The Rev. T. G. Bonney, F.R.S., delivered a lecture in Cambridge on November 25, on "A Desert Phase in the Development of Britain." Dr. H. H. W. Pearson, of Gonville and Caius College, professor of botany in the South African College, Cape Town, delivered a lecture, on November 19, on "A Botanical Journey in Southwest Africa."

An oil portrait of the late John T. Duffield, for many years professor of mathematics at Princeton University, has been added to the collection in Nassau Hall.

At the opening meeting of the Institution of Electrical Engineers, London, on November 11, a marble bust, by Mr. Hamo Thornycroft, of the late Dr. John Hopkinson, F.R.S., past-president of the institution, was presented to the institution by Professor Bertram Hopkinson on behalf of his mother, Mrs. John Hopkinson.

Dr. William James Russell, F.R.S., formerly lecturer in chemistry in the Medical School of St. Bartholomew's Hospital, died on November 12, at the age of eighty years.

The death is also announced of Dr. C. G. Graham, formerly professor of chemical technology at University College, London, at the age of seventy-four years.

Dr. John S. Coulter, professor of botany in the University of Chicago, gave recently an address before the Science Club of the University of Wisconsin, held to celebrate the hundredth anniversary of Darwin's birth.

President Charles R. Van Hise, of the University of Wisconsin, recently addressed the members of the honorary agricultural society at Iowa College, Ames, Ia., on "The Conservation of Our Natural Resources," and the St. Louis Academy of Science and St. Louis Pedagogical Society, in joint session, on the same subject.

Professor Richard E. Dodge, of Teachers College, Columbia University, gave an illustrated lecture on "Desert Life" before the geological department and the faculty of Colgate University on November 22. This was the first of a series to be given during the winter; the other lecturers being Professor W. M. Davis, of Harvard University, Professor James F. Kemp, of Columbia University, and Mr. Cyrus C. Adams, of the American Geographical Society.

The fifth course of lectures by the Harvey Society, to be given in the New York Academy of Medicine on Saturday evenings, includes the following:

December 4—Professor Otto Cohnheim, University of Heidelberg, "The Influence of Sensory Impressions on Scientific Deductions."

December 11—Professor T. G. Brodie, University of Toronto, "Renal Activity."

December 18—Professor Carl G. Huber, University of Michigan, "Renal Structure."

January 15—Professor Ludwig Hektoen, University of Chicago, "Certain Phases of the Formation of Antibodies."

February 19—Dr. Eugene L. Opie, The Rockefeller Institute, "Inflammation."

March 5—Professor Adolf Meyer, Johns Hopkins University, "The Present Status of Aphasia and its relation to Psychopathology."

March 19—Professor A. Magnus-Levy, University of Berlin, "Pathology and Therapy in Diseases of Metabolism."

THE International Committee for the Study of Methods of Control of Bovine Tuberculosis will hold its first meeting at Buffalo on December 13.

THE German National Museum at Munich has asked Dr. Lowell, director of the Lowell Observatory, for records of the observatory's work for their archives and permanent exhibition, comprising: (1) A series of photographs of Mars; (2) photographs of Jupiter; (3) spectra of Mars showing water vapor and comparison spectra; (4) spectra of the other planets; (5) the characteristic star spectra exhibited at Dresden last summer by Mr. Slipher.

THE annual exhibition of apparatus by the Physical Society of London will be held on December 14, when the exhibition will be open from 3 to 6 in the afternoon and from 7 to 10 in the evening.

THE chancellor of the University of Kansas is the state sealer of weights and measures, and Chancellor Strong has just caused to be mailed to the county officers concerned and others interested, copies of a bulletin on Kansas Weights and Measures. This bulletin gives specifications for town, city and county standards, and instructions to sealers and inspectors, and also the laws of Kansas relating to weights and measures. In the introduction to the bulletin, the chancellor says that "Though not at present fully recognized, the sealer of weights and measures should be one of the most important public officials in his community."

UNIVERSITY AND EDUCATIONAL NEWS

THE Catholic University of Washington will receive $120,100 by the will of Mrs. Emily Lusby, of Baltimore.

THE *Educational Times* states that the committee appointed by the British chancellor of the exchequer to consider the apportionment of the £15,000 additional grants which he proposes to give to the University of Wales and its three constituent colleges have recommended the following allocation, viz., £1,500 per annum to the university for fellowships in arts and sciences; £1,500 a year to the Cardiff Medical School; £4,000 each to the colleges at Bangor, Aberystwyth, and Cardiff to provide increased salaries to the staffs, further equipment for libraries and museums and provision for tutorial assistance; and £500 each towards establishing a pension scheme.

THE University of Glasgow has received, from Miss Pollock and Mrs. Gilchrist, sisters of the late Dr. Robert Pollock, notice that they intend, in accordance with their brother's wishes, to bequeath to the university £10,000 for the foundation of a lectureship in materia medica for the encouragement of research.

DR. WILLIAM DEY, for many years a member of the University Court, Aberdeen, and his brothers have given £2,500 to the university to found a scholarship in education in memory of their father.

A SYNDICATE has been appointed at Cambridge University to consider the question of providing pensions for professors and others in the service of the university.

DR. J. S. SHEARER has been promoted to a professorship in physics at Cornell University.

MR. EDGAR I. WENGER, associate in railway engineering at the University of Illinois, has been appointed assistant professor of electrical engineering at McGill University.

AT the University of North Dakota A. H. Taylor, Ph.D. (Göttenberg) has been appointed head of the department of physics, vice G. W. Stewart, Ph.D., now of the University of Iowa, and H. E. Simpson, M.A. (Harvard), formerly professor of geology in Colby College, assistant professor of geology. J. E. Rhodes, M.E. (Clemson), has been appointed instructor in mechanical drawing; Alfred A. McAlister, M.E. (Ohio State), instructor in mining and electrical engineering;

H. W. Daudt, M.S. (Harvard), assistant in chemistry, and Miss Florence Balch, M.A. (Columbia), instructor in mathematics.

The following appointments have been made in the School of Mining, Kingston, Ont.: M. B. Baker, B.A., B.Sc., advanced from lecturer to professor of geology; Leo F. Guttmann, Ph.D., assistant professor of chemistry; R. J. Manning, M.A., lecturer on chemistry; W. D. Bonner, M.A., lecturer on chemistry; J. Robertson, M.A., lecturer on physics; G. H. Herriot, B.Sc., lecturer on mathematics; S. N. Graham, B.A., B.Sc., lecturer on mineralogy; J. A. McCrae, M.A., M. L. Hersey fellow in chemistry; B. Rose, B.Sc., assistant in mineralogy; B. E. Norrish, B.Sc., assistant in drawing.

The council of King's College, London, have appointed Dr. David Waterston as professor of anatomy, in succession to Professor Peter Thompson, appointed professor of anatomy in Birmingham University. Dr. Waterston was lecturer in anatomy in the University of Edinburgh. Dr. George C. Low has been elected lecturer in parasitology and medical entomology.

Mr. W. S. Abell, instructor in naval architecture at the Royal Naval College, Greenwich, has been appointed to the chair of naval architecture in Liverpool University, endowed by Mr. Alexander Elder.

Dr. E. von Tschermak has been appointed professor at the Hochschüle für Bodenkultur, Vienna.

DISCUSSION AND CORRESPONDENCE

THE EFFECTS OF RAPID AND PROLONGED DEEP BREATHING

The following results of simple experiments may be of sufficient general interest to warrant publication in the columns of Science. They are in no sense new, but are described by way of emphasizing important facts which have been generally neglected and not with any pretense to originality.

The experimental results to which I refer show the effect of enforced deep breathing over a period of several minutes on various functions of the human body. These effects are of several kinds and a few of the simpler ones may be summed up as follows: (1) material increase in the length of time the system can do without respiration; (2) effective mental stimulant; (3) material increase in physical endurance for a short time; (4) rise in the frequency of pulse beat.

1. It has been noticed by others that deep violent breathing for several minutes so changes the system as to make respiration unnecessary for perhaps as much as five minutes after this preparatory breathing is over. In my own case I have found that four minutes' enforced breathing makes it possible to hold the breath for three minutes and a half, whereas without this preparation 56 seconds was my limit. The time during which it is possible to do without respiration increases, of course, with the length of time during which the preparatory breathing is carried on. The increase does not go on indefinitely, but reaches a definite limit, beyond which further length of time given to preparatory breathing does not increase the time during which the breath may be held. Below is a table taken from a curve which represents experiments on myself. The limit (3 minutes 34 seconds)

(*a*) Length of time in minutes devoted to deep breathing.

(*b*) Time in minutes and seconds during which the breath may be held after preliminary breathing is stopped.

(*a*)	0	¼	½	¾	1	2	3	4
(*b*)	0.56	1.24	1.39	1.54	2.12	3.00	3.26	3.34

which is indicated in this table would doubtless differ with different people. It should be noticed that the preparatory breathing is effective long after the "washing out" of the lungs must have been completed. The change produced in the system is certainly, therefore, more fundamental than a lung change, and would appear to a layman to indicate a temporary change in blood constitution.

2. The effect as a mental stimulant is very pronounced. I have noticed in my own case that mental fatigue may be postponed, far beyond the usual point, by two minutes of

rapid deep breathing at half-hour intervals. A feeling of sluggishness or sleepiness may be almost completely dispelled. I have never noticed any reaction as in the case of most stimulants and altogether it seems to me very satisfactory.

3. The effect on muscular fatigue is also striking. A difficult arm exercise with heavy weights which I could not repeat under ordinary circumstances more than twenty times, I found after four minutes of this preparatory breathing that I could do twenty-seven times, *i. e.,* about thirty per cent. more. This increase I found to exist at all stages of fatigue, as might be expected.

4. The pulse beat goes up very rapidly while the breathing is continued, in my own case from about 65 to 106 after four minutes' breathing.

Another curious effect which perhaps is worth mentioning is the apparent rapid lapse of time during the latter half of a hard breathing period. This change in the time-sense is very noticeable.

I might add, in conection with paragraph one, that a friend of mine has found a five-minute limit to the time during which he is able to hold his breath after the preliminary breathing.

I should not have ventured to describe phenomena which are so easily in the reach of every one, had I not found in people at large, and even among scientific men, a surprising ignorance as to their existence. I have seen some very amusing betting on how long it was possible to hold the breath, and have seen the cock-sure bettor laid low by not knowing of this possible resource of his adversary.

As a mental stimulant, and as a means to increase the time during which the system can do without respiration, violent breathing might find considerable useful application, and daring rescues from suffocation are common enough to make a knowledge of this possible threefold endurance without air of no little value.

D. F. COMSTOCK
MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
November 3, 1909

ESPERANTO

MR. J. D. HAILMAN'S interesting letter on the use of Esperanto by scientific men[1] is, I venture to think, somewhat misleading. He says (p. 561):

> This solution is the world-wide adoption of an *international* language—a second language which all will learn in addition to their natural tongue. . . .

The chemist, in order to be moderately well equipped, requires a good reading knowledge of English, French and German. Suppose we take a somewhat extreme case and assume that after January 1, 1910, under penalty of instant death, all chemical communications must be made in Esperanto, what would be the effect? Apart from the possible creation of a few desirable vacancies, the only result of such a law would be that chemists would have to know at least *four* or *five* languages, including Esperanto, instead of *three* or *four,* as at present. The reason for this is, of course, that the greater portion of the facts and theories which constitute chemistry has been contributed, hitherto, in English, French or German and, in many cases, it is absolutely necessary to have an author's original words.

The same conditions doubtless apply, *mutatis mutandis,* to other branches of knowledge.

I have no desire to obtrude an opinion regarding the merits and defects of Esperanto, nor to say anything as to the desirability or otherwise of an international language. I believe, however, that it is timely to point out that the adoption of Esperanto will involve an increase to the weight of languages which the scientific worker has to carry and that it will not be an alleviation of his burden. It is only fair to call upon the enthusiastic propagandists of Esperanto to state this fact clearly during their missionary labors.

J. BISHOP TINGLE
MCMASTER UNIVERSITY,
TORONTO, CANADA,
October 28, 1909

SCIENTIFIC BOOKS

Descendenz und Pathologie. Vergleichend-biologische Studien und Gedanken. By

[1] SCIENCE, October 22, 1909.

D. von Hansemann. Pp. 488; no illustrations. Berlin, A. Hirschwald. 1909.

There is considerable room for doubt whether the title of this fascinating volume was well chosen and whether a more correct title would not be "Evolution and a Pathologist" instead of "Evolution and Pathology." But, while there is little pathology, as such, the subject matter is presented by a master mind whose training has been in the field of abnormalities, and many a well-worn biological theme is clearly illustrated by facts from his own domain of science. In his introduction von Hansemann states that his book is for those who are familiar with the principles of evolution, but who have no far-reaching knowledge of pathology; and for those pathologists who have been so absorbed in pursuing their own goddess that they lack insight into the subject-matter of modern evolution. It would be expected, therefore, and the expectation is fully realized, that the essential points in the philosophy of evolution would be presented in the clear light of a well-trained mind and by one who views them somewhat objectively.

A vigorous supporter of Darwin, von Hansemann pays his respects to neo-vitalists by calling their philosophy pure speculation, and as such really less scientific in spirit than that of the old nature philosophers (p. 8), and throughout the book he returns again and again to the dicta of Darwin and of Weismann. The chapters on Preformation, Species and Varieties, Variability, Conditions of Constancy, Altruism, Design (Zweckmässigkeit) and Orthogenesis, Lamarckism, Functional Adaptation, Epidemics and Physiological Death, are devoted mainly to arguments in favor of the origin of variations. While much of this matter is old and many of the arguments somewhat hackneyed to a biologist, there is, nevertheless, a constant novelty in the ever-present point of view of the pathologist and a not inconsiderable originality in the interpretation of facts. Here, especially, are to be noted his views on variability, on altruism, on regeneration and transplantation, and on epidemics.

The key-note of his view on variations is sounded in the sentence "die ganze Fragestellung in Bezug auf die Entstehung der Variabilität eine unrichtige ist" (p. 150), and he takes the original ground that variability is one of the fundamental properties of living protoplasm and seeking for its origin, therefore, is lost effort. If a constant tendency to vary is a fundamental property of protoplasm, then the problem of the origin of species becomes more simple by the effort to ascertain what it is that gives or causes constancy of type. The chapter devoted to this phase of his subject (Bedingungen der Konstanz) is the most interesting one in the book and is worked out with the greatest argumentative ingenuity and with a wealth of illustrations and citations. Concerning variability he says:

> Natürlich stelle ich mir diese innere Ursache nicht als irgend etwas Mystisches vor, das ausserhalb der mechanischen Erklärungsmöglichkeit liegt, sondern als eine der lebenden Materie inhärente physikalische Eigenschaft, die aus der besonderen Form der Vereinigung ihrer Atome und Moleküle erklärt werden muss und deswegen zur Definition der lebenden Substanz gehört (p. 152).

As a ball upon an inclined plane is prevented from rolling by some external hindrance, so species, having an inherent and continual tendency to vary, are prevented from changing by reason of external conditions. Adaptation means the establishing of an equilibrium between the internal forces and such external conditions. The statement of his principle is followed by a discussion of the many ways whereby constancy of type might be brought about, environmental and climatic changes, inheritance and other phenomena usually credited with bringing about variations, are here regarded as effective agents in checking the inherent tendency to vary, while in the highest types of living things, which presumably have passed through a long phylogenetic history of variations, this fundamental property has become weakened or partially lost, so that in such highest forms we find the greatest fixity of types.

The phenomena of regeneration, also, are

traced back to a fundamental property of protoplasm, and, like the capacity to vary, this property becomes more and more limited with advanced differentiation until, in the highest types of animals, the power of regeneration is much more reduced than in lower forms. This power, he thinks, still remains in the germ plasm which in higher animals becomes more and more localized in specific organs while in plants and in lower animals it is still present in part, at least, in all somatic cells, making them what Driesch calls "equipotential." Not only in different animal types does this somatic and germinal distinction exist, but among the different cells of the same individual as well, the difference being measured by their relative power to regenerate, from which it follows that "the regenerative power of a cell-type is a criterion of its differentiation" (p. 44).

The expression "struggle for existence," as used in current theories, he regards as an erroneous phrase for the description of natural phenomena. The conditions throughout all nature, he thinks, indicate a "compromise" of individuals bound by the fundamental law of altruism which is as strikingly operative between varieties, species and races as it is between the various organs, tissues and cells of the individual.

Manche Lebewesen stehen in so enger altruistischer Beziehung zueinander, dass sie bei künstlicher Aufhebung derselben zu Grunde gehen. Bei anderen ist dieser Verhältnis ein viel locheres, ja viele Arten stehen so weit auseinander, dass die altruistischen Beziehungen zwischen ihnen garnicht mehr erkannt werden können. Man kann mit Sicherheit behaupten, dass überall, wo diese Beziehungen enge sind, eine Abhängigkeit in der phylogenetischen Entwicklung bestanden hat. Ganz besonders deutlich tritt das bei Anpassung von Instinkten zweier Tiere in die Erscheinung, z. B. bei der Symbiose des Einsiedlerkrebses und der Aktinie, und man ersieht daraus, dass diese längst anerkannte und auch schon von Darwin hervorgehobene Tatsache sich aus den Erscheinungen des Altruismus ausreichend erklärt (p. 225).

Bearing the title it does, one naturally looks under the heading "Epidemics" for something more akin to pathology than the other chapters present. But a zoologist would have little use for the medical information to be gathered here. The term "epidemic" is used in its broadest sense and not at all with the usual significance. In using it biologically, he differs widely from Osborn and others who have made use of the term in a pathological sense and in connection with disease as one of the factors in the extinction of animals of the past and present. Von Hansemann uses the term to indicate an abnormal or unusual increase of numbers of a race or species of animals; he would not speak of an epidemic of typhoid fever but would describe such a wide-spread illness as due to an epidemic of *Bacillus typhosus*. Great collections of fossils of one type in one geologic bed similarly would be "epidemics." The reason for such epidemics might be unusual abundance of food or unusual absence of adverse environmental conditions, such as absence of enemies or, in a pathological sense, absence of protective agents on the part of the host. Such epidemics, he argues (p. 459), would be another means of increasing varieties and species through variation, since increase in numbers means proportional increase in the number of variants.

The limits of a review do not permit of an enumeration of the hundreds of other interesting points that are brought out with delightful clearness and fairness of presentation. Many of his conclusions are, indeed, open to question, especially such as result from a too superficial view of the problem concerned, but these are due more to ignorance of the great mass of facts involved than to faulty logic. Taken as a whole the book is full of valuable suggestions and is an undoubted contribution to the philosophy of evolution, and as such will be gratefully received.

GARY N. CALKINS
COLUMBIA UNIVERSITY

Cave Vertebrates of America—A Study of Degenerative Evolution. By CARL H. EIGENMANN, Professor of Zoology, Indiana University. 241 pages, 31 full-page plates and 72 text figures. Carnegie Institution of Washington. June, 1909.

Dr. Eigenmann has combined in this one work the results of his various papers on the cave vertebrates of America. The title is slightly misleading, as he includes blind vertebrates which do not inhabit caves. He also includes the results of others who have been interested in the study of blind vertebrates. It is a very comprehensive work dealing with species distributed over the greater part of the United States from the Pacific to the Atlantic and as far south as Cuba, the West Indies and northern portion of South America.

The main bulk of the work is upon the eye as affected by the absence of light. However, he devotes considerable space to morphological, zoological and physiological points of interest in connection with the animals studied. The other special senses were experimented upon and studied in some detail. The embryology of some forms was studied with special reference to the development of the eye.

After a short introduction he devotes considerable space to a general consideration of caves and cave fauna. In this he deals with the relation of caves to the rest of the universe; the environment of caves; the origin and distribution of cave animals; the food supply; the relation of the age of caves to the variety of cave fauna; the tendency to divergence in epigean fishes and convergence in cave forms.

As to the origin of cave fauna, he holds that only those forms which are negatively heliotropic or positively stereotropic are able to adapt themselves to cave life; that species depending on sight for procuring food can not adapt themselves to the environment of the cave. The cave fauna is not the result of accidental entrance of epigean forms. The aquatic cave fauna has developed from those forms adapted to live in dark and secluded places following the stream as it has gradually through ages formed subterranean channels. The non-aquatic forms are of more recent origin and have migrated into the caves after their formation. These are gradually adapting themselves to the more remote parts of the caves.

The author then takes up in detail the blind and cave vertebrates and their eyes. This comprises the main part of the work, consisting of 210 pages illustrated by 29 full-page plates and 72 text figures. Although, with the exception of birds, all classes of vertebrates are represented by species having degenerate eyes, by far the greatest number is found in fishes and fish-like vertebrates.

Only two species of mammals are described —the common mole and the cave rat. The former has very degenerate eyes, while in the latter the eyes are practically normal and resemble very closely those of the common gray rat.

Of the amphibians only four species of salamanders are described as inhabiting caves. Three are from the caves of the Mississippi valley, the fourth is from the underground streams near San Marcos, Texas. Detailed descriptions of these eyes are given.

Three reptiles are described: *Amphisbæna punctata,* a blind legless lizard from Cuba; *Rhineura floridana,* a legless burrowing lizard from Florida; and *Typhlops lumbricalis,* a blind snake found generally distributed in the West Indies and Guiana.

After a brief description of the eye of a fish (*Zygonectes notatus*) having normal vision and closely related to the blind fishes, he begins a detailed description of the different species of blind fishes. Although special reference is given to the eye, he treats of such general topics as general habits, respiration, reactions to light, tactile organs, the ear, anatomy of different organs, reproduction, etc.

He describes the development of *Amblyopsis* from the egg, being successful in rearing one to the age of ten months. He corrects the erroneous idea that *Amblyopsis* is viviparous. The mother deposits the eggs in the gill clefts, where they are retained during development till the young reach a length of about 10 mm. and the yolk is mostly absorbed.

Tactile organs are extremely well developed and these take the place of the lost visual sense. The ear is normal. In regard to their power of hearing, he says:

. . . if we define hearing to be the sensation

received through the ear and caused by vibrations either in the air or water, the experiments cited do not enable one to conclude definitely whether the blind fishes hear or not. If they do hear, their power in this direction is very limited.

Twelve species of blind fishes are dealt with. One, *Typhlogobius californiensis,* found under the rocks at Point Loma, near San Diego, Cal., has normal eyes when young, but degenerate in the adult. Another, a blind catfish (*Amieurus nigrilabris*) from Pennsylvania, is briefly described by Cope. The remaining ten species of blind fishes were procured from the caves of central and southwestern United States and from Cuba. Eight of these belonging to the Amblyopsidæ ("blind fishes") inhabit North America. The other two, members of the Brotulidæ, were secured in the caves of Cuba.

Of the Amblyopsidæ three species of *Chologaster* (*cornutus, papalliferus* and *agassizii*) have well-developed eyes. The other species of Amblyopsidæ, *Amblyopsis spelæus, Troglichthys rosæ, Typhlichthys subterraneus, Typhlichthys osborni* and *Typhlichthys wyandotte,* have only vestigial eyes.

The two Cuban species, *Stygicola* and *Lucifuga,* were both found to be viviparous. No definite breeding season could be determined, as females with young were found at various times throughout the year. "The eye decreases in size progressively from birth to extreme old age concomitantly with the appearance of masses of pigment cells in the orbital fat." Shriveling may occur in one eye of an individual while the other may show a massing of pigment cells. All structures connected with the eye show this progressive reduction from birth to old age.

The closing chapter discusses the causes of individual and phyletic degeneration. The following views of others concerning the cause of degeneration are discussed: (1) Organs diminish with disuse (Lamarck, Roux, Packard); (2) through a condition of panmixia a reduction occurs (Romanes, Lankester, Morgan, Weismann); (3) natural selection (Darwin, Romanes); (4) struggle of organs for room and food (Roux, St. Hilair); (5) the struggle between soma and germ for greatest efficiency at least expense (Lendenfeld); (6) germinal selection (Weismann), (7) process of mutation.

The author's views of the causes of degeneration may best be given in his own words:

> The Lamarckian view, that through disuse the organ is diminished during the life of the individual, in part at least on account of the diminution of the amount of blood going to a resting organ, and that this effect is transmitted to succeeding generations, not only would theoretically account for unlimited progressive degeneration, but is the only view so far examined that does not in the face of it present serious objection. Is this theory applicable in detail to the conditions found in the Amblyopsidæ? Before going farther, objections may be raised against the universal assumption that the cessation of use and the consequent panmixia was a sudden process. This assumes that the caves were peopled by a catastrophe. But it is absolutely certain that the caves were not so peopled, that the cessation of use was gradual and the cessation of selection must also have been a gradual process. There must have been ever widening bounds within which the variation of the eye would not subject the possessor to elimination.
>
> *Chologaster* is in a stage of panmixia as far as the eye is concerned. It is true the eye is still functional, but that the fish can do without its use is evident by its general habit and by the fact that it sometimes lives in caves.
>
> The present conditions have apparently existed for many generations, as long as the present habits have existed, and yet the eye still maintains a higher degree of structure than reversed selection, if operative, would lead us to expect, and a lower degree than the birth mean of fishes depending on their eyes—the condition that the state of panmixia alone would lead us to expect. There is a staying quality about the eye with the degeneration, and this can only be explained by the degree of use to which the eye is subjected.

Three general conclusions may be added:

(1) The bleached condition of animals living in the dark, and individual environmental adaptation, is transmissible and finally becomes hereditarily fixed. (2) Ornamental secondary sexual characters not being found in blind fishes are, when present, probably due to visual selection. (3) Individual degeneration of the eye may begin in even earlier stages of development until nearly

the entire development becomes affected, that is, functional adaptations are transmissible.

James Rollin Slonaker
Leland Stanford Junior University

Effects of the Rays of Radium on Plants. By Charles Stuart Gager. Memoirs of the New York Botanical Garden, Vol. IV., 1908. Imp. 8vo, viii + 278 pages, 73 figures and 14 plates. Price $2.00.

As known to several botanists, the author was engaged for some time in studying the effects of radioactivity on various plant processes. The present volume represents the sum and substance of approximately four years of labor and is presented as a pioneer investigation; comprehensive in scope and as offering initial suggestions for several important problems.

During the research period "standard preparations of the purest radium bromid yet obtained" were placed at the disposal of Dr. Gager by Mr. Hugo Lieber, of New York City. As a result of the cooperation of liberality and investigation we may now feel quite certain that the rays of radium constitute a stimulus to the metabolic processes in plants. In conformity with other stimuli, that of radioactivity exhibits a minimum, optimum and maximum. Metabolic processes in general, whether constructive or destructive, are accelerated by intensities of stimulation between the minimum and optimum, while greater intensities beyond the optimum retard until death follows at the maximum.

Looking more particularly at the individual topics treated, we find an initial chapter of fourteen pages which constitutes a digest of about one hundred and fifty citations. In clear and rather popular style the essential facts of the nature of radioactivity are presented.

The universal presence of radioactivity in soil, water, rain, snow, etc., is elaborately discussed and the obvious deduction drawn that living matter can hardly escape its influence. Such being the case, any sudden change in the intensity of the emanations would be expected to constitute a stimulus to the exposed organisms.

Quite appropriately some attention is given to the undemonstrated conclusions of various authors regarding radioactivity as a property of wood, flowers and other plant organs. The unsuccessful efforts to artificially create life through the influence of radium are explained. An historical review of previous work done on both plants and animals occupies several pages.

The power of radium to affect the germination of seeds and the subsequent growth of the seedlings is clearly shown by the author's own work. A given plant can be educated, so to speak, to endure an intensity of stimulus which on first exposure retarded growth. This shows that since radioactivity is so universal in nature that plants are probably naturally attuned to at least a low intensity which may be gradually increased without disturbing the normal processes in the plant. Freshly fallen rain may have sufficient radioactivity to retard growth of plant organs. The same may be true of tap-water previously exposed to the emanations of radium.

Alcoholic fermentation, and respiration, both aerobic and anaerobic, were found to respond to stimulus. On the other hand, tropistic responses were not with certainty demonstrated.

The profound influence of the rays of radium is manifest if we look at the abnormalities arising in the cells and tissues of plants exposed. Thus in the hypocotyls of beans, lupins, etc., retardation of growth was accompanied by a lack of coordination in histogenesis, stoppage of cell-division, acceleration of tissue-differentiation, decrease in size of the cells. In a given case any one or all of those effects may be found. Mitosis in any of its phases is likely to be profoundly modified with marked distortion of the mitotic figures and disturbance of the normal processes of nuclear division.

The attempts to induce mutation by radioactivity were not continued to success, though some intimations were obtained that it may be possible to do so.

The paper closes with an extended theoretical discussion of about seventeen pages.

From the facts included in this descriptive review it is evident that this work has a com-

prehensive value both to those who may be interested from the popular standpoint and to those who intend to work themselves. The bibliography includes about five hundred and sixty-five citations.

For valuable counsel during the earlier progress of the work the author makes acknowledgment to Professor Wm. J. Gies.

RAYMOND H. POND

BOTANICAL NOTES

THE EAR-ROTS OF INDIAN CORN

Two recent bulletins deal with this serious trouble to our most important crop. The first is "The Life-History and Parasitism of *Diplodia zeae* (Schw.) Lev.," by F. D. Heald, E. M. Wilcox and Venus W. Pool, in the Twenty-second Annual Report of the Nebraska Agricultural Experiment Station, January, 1909. This paper gives the results of the investigations which have been in progress for several years as to the cause of the extensive loss in Nebraska from ear-rots. The complete life-history of the fungus is worked out, the results of inoculations given and its distribution in the state shown. The illustrations are especially fine.

The second paper bears the title "Ear Rots of Corn," by Thomas J. Burrill and James T. Barret (Bull. No. 133, Ill. Agric. Exp. Sta., Feb., 1909). This a more extensive bulletin, largely upon the same subject as the earlier publication by the Nebraska Experiment Station, and is one which merits the careful reading of all plant pathologists, mycologists and others interested in the botanical or practical aspects of the subject. In Illinois the annual loss from ear rots is from two to four and a half per cent. of the entire crop, representing a money loss of from two to five and a half million dollars. This bulletin is the result of extensive investigations covering several years. Ninety per cent. of the rot was found to be due to *Diplodia zeae* (Schw.) Lev. The fungus was thoroughly studied in laboratory and field; inoculations were made to show the time and mode of infection; its round of life was carefully worked out, and means of prevention suggested.

Three species of *Fusarium* are largely responsible for the other rots. The characteristic rot of each species is described but work upon these forms is still incomplete.

MORE DARWIN LITERATURE

IT may be well to record here several addresses that have seen the light in various places in printed form:

"Darwin as a Naturalist: Darwin's Work on Cross Pollination in Plants," is the title of Dr. William Trelease's address before the Botanical Society of America last winter, and published in *The American Naturalist* for March, 1909. This is first a general estimate of Darwin as a student of plants, followed by an analysis of his contributions to our knowledge of the mechanism and meaning of cross pollination, including a list of his publications (twenty-two titles) on pollination and fertilization.

"Darwin and Botany" is the title of a short address given by Dr. N. L. Britton at the American Museum of Natural History on February 12 last, and published in the *Popular Science Monthly* for April, 1909. In this the writer traces the evolution of Darwin's contributions to botany, and declares that "the value of the impulse given by Darwin to botanical investigation in all its branches is beyond estimation."

Professor J. M. Macfarlane's first address, "Darwin in Relation to his own and the Pre-Darwinian Period," before the faculty and students of Pennsylvania College, February 12, is a summary review of the period preceding Darwin's work, and the steps by which the different phases of the doctrine of evolution have been attained. His second address, "Lessons from the Life and Writings of Charles Darwin," before the members of the Philadelphia Girls' High School, February 15 and 23, brings out Darwin's persistence in his work, his self-denial, his sweet spirit, free from envy or jealousy and his faith in the ultimate dominance of truth. His third address, "The Legacy Left us by Darwin and his Collaborators," before the Linnean Society, the faculty and students of Franklin and Marshall College, February 27, dwells upon

the evolution and transformation in thought that has been one of the greatest results from the work of the great naturalist. These three addresses have been brought together and privately printed, making a pretty 64-page pamphlet with the general title "Charles Darwin: Three Appreciations, by J. M. Macfarlane."

Here may be listed Dr. R. G. Eccles's "Parasitism and Natural Selection: A Medical Supplement to Darwin's Origin of Species," first published in the *Medical Record,* July 31, 1909, and now reprinted as a 34-page pamphlet. The author emphasizes the part taken by parasites in the evolution of organisms, not only in the present, but also in the remote past.

A NEW BOTANICAL HISTORY

Proofs have been received of the first part of Dr. E. L. Greene's "Landmarks of Botanical History," now in the press and soon to be published in the "Smithsonian Miscellaneous Collections." When completed the work will consist of three volumes, and judging from the pages we have examined it will be a most helpful and discriminating contribution to our knowledge of the development of the science. At the outset the author makes the rather startling statement that "What is here undertaken is not a history of botany." He has not planned to present "in chronological succession the long line of the contributors to the upbuilding of this science with an account of the best contributions each has made," but rather to touch here and there upon the work accomplished by botanists in the gradual development of botany from its earliest beginnings. In the phrase of to-day, he proposes "to touch the high points" in the history of botany.

Every botanist will await the publication of this book with great interest, for no man is better prepared by nature and education for this task than Dr. Greene. An early notice of the first completed volume will appear in these columns.

Charles E. Bessey
The University of Nebraska

AN INDUSTRIAL COMMISSION

Some recent developments in the relation of producers and manufacturers of cotton in the United States certainly call for a scientific study of the question with a view to devising some plans by which the elements entering into the cotton industry shall the more clearly understand the situation and be better understood by other factors of the industry.

At a recent meeting of the Georgia Industrial Association in Atlanta, Ga., the cotton mill owners of the state passed the following resolutions:

> Resolved by the Georgia Industrial Association that, owing to the disparity between the cost price of cotton goods and yarns, based upon the present price of cotton, and the market price thereof, that it is necessary for the mills of this association, as a matter of self-protection, to inaugurate and enforce the curtailment of not less than 25 per cent. of their running time.
>
> Resolved, further, that each mill of this association is instructed to make such curtailment not later than November 1, 1909, and continuing until January 1, 1910, and thereafter until the selling price of the finished product approximates its cost.
>
> We further recommend that all the mills of this association decline all offers and withdraw all quotations upon finished product at a less price than the cost thereof, based upon the price of cotton at the time of sale.

It is a well-known fact that the cotton raisers of the south have long been trying to organize themselves, so that they would be able to have something to say about the price of cotton, and in view of the present high prices, they think that they have cause to rejoice at their efforts, and to believe that they have scored a victory. While the writer believes that the law of supply and demand will eventually regulate, it must be conceded that this misunderstanding is calculated to lead to serious results, if the cotton industry of the south and country fails to grasp its meaning.

The National Farmers' Union of America in answer to the above resolutions recently issued a statement through the public press that "curtailment of output by cotton mills

on account of high-priced cotton is a humorous bluff." This view is of course taken up by the farmer, who is not in a position to see the seriousness of the situation.

The American Cotton Manufacturers' Association issues in the *Textile Manufacturer* the following reply to President Barrett, of the Farmers' Union:

> The recent utterance of President Barrett, of the Farmers' Union, and the editorials of the *Cotton Journal* are in bad taste, and show a surprising lack of grasp of the situation.
>
> The cotton manufacturers of the south are interested in the development and welfare of the south and are big and broad enough to realize that a fair price for cotton means prosperity for this section.
>
> The farmers are in the midst of prosperity while the mills are in distress. Both are linked together in the general prosperity of the south and the farmer should show his willingness to cooperate.

This relation between the two great factors of the cotton industry of the south grows a little more critical with each report that comes from either side without any possible means for either side to know the status—the real status—of the other. The writer is inclined to believe that such a matter is of national importance and should call for the best thought of the country. If these two great organizations, the producers, on the one hand, and manufacturers, on the other, could be made to more clearly understand the other by a National Industrial Commission or Arbitration Board, the country would be the gainer far out of proportion to the cost of maintaining the commission.

The mills concede that the price of cotton is not too high, yet they can not fail to see that such action as they have taken actually cost the farmers of the country right about $450,000 the tenth day after the meeting of the Industrial Association. Possibly the farmers should help bear the burden, but the real issue is this—the mills should not have the privilege of passing judgment on the matter for all concerned, which it virtually amounts to, since their action seems to vitally affect the price of cotton. The point uppermost in the mind of the writer is that all should help bear the burden, but let the matter be submitted to an arbitration commission, whose duty it shall be to investigate the cost of raising cotton, and the cost of manufacturing, and such report as they make annually, or oftener, be distributed among all people. The commission need not confine its work to any particular line of industry, but should turn its attention to all matters of national importance about which there is likely to arise a misunderstanding. This commission could well be considered a common resort for justice in proportion to its authority and influence.

When we contemplate the fact that Great Britain is developing cotton growing in all her colonies, and will sooner or later be in position to supply her own mills with the raw material, the matter assumes a new interest. A letter comes by this mail from the director of agriculture, Zomba, Nyasaland, British East Africa, that the cotton crop will be increased over 29 per cent. this year over last year's crop. The general outlook for the British government is very bright, and surely there is no time for delay in adjusting our own affairs to the best interests of the nation. England is in doubt as to the meaning of the inconsistency of the present situation in America, as shown above, since short crop means high price for raw material, and yet an overplus of manufactured articles seems to be the explanation of the low price of finished material. "It is difficult to get at the truth from contradictory statements of this kind," comes from an English review.

R. J. H. DELOACH
STATE COLLEGE OF AGRICULTURE,
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SPECIAL ARTICLES

RESTING SPORES OF THE POTATO FUNGUS (PHYTOPHTHORA INFESTANS)

THE potato fungus, *Phytophthora infestans,* has been carried in pure culture in the botanical laboratory of the University of Vermont continuously since 1904. Various natural and artificial media have been tried in the hope of securing additional information as to the ability of the fungus to produce

sexual or resting spores. As reported in our earlier paper,[1] oogonium-like bodies were found almost immediately after the inception of this work, in cultures on raw potato, lying in the mycelium close to the surface of the substratum. Subsequently they were found in greater abundance in potato gelatin cultures, here imbedded in the culture medium. Growth with varying degrees of vigor has also been secured upon several other synthetic media, including some modifications of the lima-bean agar, recommended by Dr. G. P. Clinton. The oogonium-like bodies have, however, been found but rarely upon any medium except the potato gelatin and the lima-bean agar. Under favorable circumstances they have been obtained in these in sufficient abundance to permit much more convincing study of the details of their development than was reported in our former paper. The most important advance, however, is the discovery of what appears to be fully matured resting spores. The oogonium-like bodies are about 30 microns in diameter, hence distinctly larger than the regular sporangia (conidia) and so different in appearance and mode of production as to preclude the idea that they are closely related to them. The character of the wall especially differentiates these two reproductive bodies, the oogonium-like bodies soon developing a thicker wall, immediately in contact with cytoplasm, which may show stratification and which in turn may be enveloped in an external envelope, of which the details as to development and structure vary with the medium in which they lie. No body clearly comparable to an antheridium has as yet been discovered. Nevertheless numerous examples have recently been found where these oogonium-like bodies have apparently developed into mature resting spores. These have a thick spiny brown exospore with dense granular contents, bearing a general resemblance to the oospores of related Peronosporales. None have as yet been germinated hence it remains to be proved whether they do actually function as resting spores. We have found similar bodies in potato leaves rotted by *Phytophthora*. There is need of further painstaking work, including cytological studies now being made by Dr. Lutman, before final conclusions are justifiable, but the evidence at hand encourages the hope that we have in hand the long sought for resting spores of *Phytophthora infestans*.

L. R. Jones

Botanical Laboratory,
University of Vermont,
October 15, 1909

[1] A paper dealing with this subject was read by the present writer and N. J. Giddings before the last meeting of the Botanical Society of America and abstracted in Science (N. S., XXIX., 271). The removal of Mr. Giddings to West Virginia has left the responsibility for directing further study with the writer, who is fortunate in now having the assistance of Dr. B. F. Lutman and Mr. C. R. Orton. Professor H. A. Edson has also assisted, especially in devising culture media.

Collection of the æcial stage of Calyptospora columnaris (Alb. & Schw.) Kühn

The æcial stage of the blueberry rust, *Calyptospora columnaris* (Alb. & Schw.) Kühn, was collected on *Abies balsamea* near Pictou, N. S., by the writer on July 14 of the present year.

Wintered telial material of this rust which is abundant on the blueberry (*Vaccinium pennsylvanicum*), was sent to Dr. J. C. Arthur for his culture work. He found the teliospores viable and on his suggestion search was made in the vicinity of the collection for the æcial stage. A *Peridermium* was found on the leaves of *Abies balsamea*, which agreed with the description of *Peridermium columnare*. Part of the collection was forwarded to Dr. Arthur, who determined it as the æcial stage of *Calyptospora columnaris*, and this as the first collection in North America.

This *Peridermium*, which could be easily recognized in the field by its yellow color, due to the orange-colored spores, was found sparingly distributed over an area of several square miles on the young leaves of the lower branches of its host. In no case was it abundant, only a few leaves being affected. In several places the leaves of young trees a few inches from the ground showed a more pronounced infection,

and in every instance the swollen stems of rusted blueberry grew among or just beneath the infected leaves.

The delicate peridium disappeared in a few days after the escape of the spores, or the infected leaves curled up and fell from the tree. Several collections were made during the summer, the last being on August 15.

W. P. FRASER

PICTOU, N. S.

THE SMOOTH HOUND, AND SOME OTHER FISHES IN NEW JERSEY

AMONG a collection of fishes made during the past season at Corson's Inlet, by Dr. R. J. Phillips, is an interesting fœtal shark. It is one of six removed from a female which measured three feet nine inches, taken on May 16, and was attached to the uterus of the mother by a placenta. This fact is interesting in that it points to the alleged essential character distinguishing *Cynais* from *Mustelus*. Upon comparison with other examples from our Atlantic coast, and the types of *Mustelus equestris* Bonaparte (=*Mustelus mustelus*), I find no difference whatever, except as may be allowed due to age. The presence of a lateral cusp on each side of the median one, in the case of the teeth, is distinct in small specimens, but as they grow larger the outer or anterior teeth at least seem to be smoother. I shall therefore feel obliged to consider the common smooth hound along the New Jersey coast to be *Mustelus mustelus*, thus substantiating Dr. Günther's record for New York in 1870. A fine small example of *Elops saurus*, the first definite record for this fish in New Jersey waters, was taken October 9. *Clupea harengus*, taken on June 6, is also the first definite record in New Jersey for that species. Other interesting species obtained are: *Eulamia milberti, Anchovia brownii, A. mitchilli, Kirtlandia vagrans laciniata, Menidia menidia notata, Mugil cephalus, M. curema, Selene vomer, Trachinotus falcatus, Pomatomus saltatrix, Orthopristis chrysopterus, Stenotomus chrysops, Micropogon undulatus, Menticirrhus americanus, Stephanolepis hispidus, Alutera schœpfii, Tetrodon maculatus, Chilomycterus schœpfi, Myoxocephalus œneus, Prionotus carolinus, P. evolans strigatus* and *Pseudopleuronectes americanus*.

HENRY W. FOWLER

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.,
November 6, 1909

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A REGULAR meeting of this section was held at the American Museum of Natural History on October 11, 1909. In the absence of Mr. Frank M. Chapman, chairman of the section, Professor N. L. Britton presided. The evening was devoted to a paper on "Common Mushrooms and How to Know Them," by Miss Nina L. Marshall.

Miss Marshall, who is the author of a popular book on mushrooms, exhibited a series of beautifully colored slides illustrating the principal types of mushrooms. She dwelt especially on the ecology of the different forms and on their economic importance to man. The distinctive characters of the poisonous and non-poisonous kinds were emphasized.

AT the regular meeting held at the American Museum on November 8, 1909, Chairman Frank M. Chapman presiding, the following papers were read:

A Naturalist in the Straits of Magellan: Mr. CHAS. H. TOWNSEND.

The speaker gave an account of personal experiences in the Straits of Magellan while a member of a scientific expedition to that region several years ago. He spoke at length of the more interesting mammals, birds, fishes and plants seen or collected. The paper also dealt with the habits of the native tribes of that region. Those living along the more westerly channels of the straits go almost naked, subsist mainly on shell-fish and, in the speaker's opinion, are the lowest among primitive races of man. They are fast disappearing and should be carefully studied.

The paper was illustrated by lantern slides mostly from photographs by the author.

A Trip through Tropical Mexico: Dr. ALEXANDER PETRUNKEVITCH.

The author spent two months during last summer in the lowlands of tropical Mexico collecting arachnida and other invertebrates for the American Museum of Natural History. The paper

dealt with his experiences in the field. Many interesting forms were observed and collected, some of which the speaker exhibited.

L. Hussakof,
Secretary
American Museum of Natural History

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 435th regular meeting of the society, held October 26, 1909, the president, Dr. J. Walter Fewkes, spoke on "The Preservation of Cliff-dwellings," his remarks being illustrated with lantern slides.

"The preservation of cliff-dwellings," said the speaker, "is one aspect of a more comprehensive problem now attracting great attention, the conservation of our resources. The protection of the antiquities of our country is imperative, for if neglected much valuable material pertaining to prehistoric America will be destroyed by the elements or by vandals in a few years." Excavation and repair of cliff-dwellings are necessary not only to put these interesting relics of the past in such condition that tourists may obtain correct ideas of this type of prehistoric architecture but also to furnish students with data for comparative studies.

The two cliff-dwellings that already have been repaired by the government are Spruce-tree House and Cliff Palace, both of which ruins are situated in the Mesa Verde National Park, Colorado.

The field work of repair of cliff-houses under direction of the Secretary of the Interior was in charge of Dr. Fewkes, who was detailed for that work by the secretary of the Smithsonian Institution. The treatment of these ruins consisted of excavation and repair. The ideal is educational and no restoration was attempted. No changes were made in the skylines of the walls, the purpose of the work being to preserve as far as possible the picturesque characters of the ruins. The condition of Spruce-tree House and Cliff Palace before and after the operations was illustrated by lantern slides made from photographs taken from approximately the same places. The speaker pointed out the many difficulties encountered in the field work, as isolation of the ruins, scarcity of water and inaccessibility of the ruins from the top of the mesa. He dwelt especially on the magnitude of the work at Cliff Palace, the largest cliff-dwelling in the southwest, and on the discovery of buried terraces having retaining walls and ceremonial rooms in the talus in front of the secular rooms.

Both Spruce-tree House and Cliff Palace have been completely excavated and repaired so that a visitor can now walk without difficulty or danger from one end to the other through deserted courts, plazas and rooms, and readily examine all architectural features. All walls in danger of falling have been repaired and new foundations provided wherever necessary.

Dr. Fewkes also threw on the screen views of the large cliff-dwellings lately discovered in the Navaho National Monument in the neighborhood of Marsh Pass, northern Arizona. While the dimensions of some of these cliff-dwellings are not less than those of Cliff Palace, they lack the picturesqueness and the fine masonry of the latter. The Navaho Monument cliff-dwellings are rarely more than two stories high and most of the ceremonial rooms are rectangular. These buildings are, however, among the best preserved in the southwest and their chambers might be called more appropriately abandoned rooms rather than ruins, the broom being in many cases more necessary than the spade to put them in condition for tourists and students. It is fortunate for historical science that these houses are now protected from vandals and it is to be hoped that their walls, some of which are tottering, will be repaired before it is too late.

John R. Swanton,
Secretary

THE WASHINGTON CHEMICAL SOCIETY

The 193d meeting of the Washington Chemical Society was held at the George Washington University, on Thursday, November 11, 1909. President Walker presided. The papers presented were: "The Rôle of Water in Minerals," by W. F. Hillebrand, and "The Exact Determination of Sulphur," by J. Johnston.

The election of officers for 1910 resulted as follows:

President—G. H. Failyer.
First Vice-president—W. W. Skinner.
Second Vice-president—J. M. Bell.
Secretary—J. A. LeClerc.
Treasurer—F. P. Dewey.
Councilors—E. T. Allen, P. H. Walker, L. M. Tolman.
Members of the Executive Committee—M. X. Sullivan, H. C. P. Weber, H. E. Patten, S. S. Voorhees.

The attendance was 106.

J. A. LeClerc
Secretary